THE BORDERLANDS OF SCIENCE

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THE BORDERLANDS OF SCIENCE

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THE BORDERLANDS OF SCIENCE

BY

A. T. SCHOFIELD, M.D.

Author of "The Unconscious Mind," "Science and the Unseen World," etc.

"The course of nature is the art of God."
Young's "Night Thoughts."

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PREFACE

My object in writing this book is to present to the reader an entirely new outlook on the subject with which it deals. The word " borderland " has hitherto been practically confined to a study of psychic phenomena ; but here the meaning is so extended as to cover all that is obscure or unproved in any science.

The book is divided into two parts : the *Light* and the *Twilight*. The light is that of science, reason, and induction, and also of revelation and deduction ; the twilight is the condition of the borderlands of the various sciences. This borderland varies in extent in each science as the scientist advances towards the central source of light ; what was borderland yesterday being annexed to the realm of ascertained and verified fact to-day, and thus the darkness is slowly dispelled. Not only so, but the scientist observes that in his progress he and his fellow-workers in other sciences ever tend to converge : a fact which irresistibly suggests the ultimate unity of all the sciences and dimly foreshadows the one great central Unity.

The book, as a whole, is popular and not technical in character. I have abstained from burdening it with a multitude of references to other works, though names of authorities are mentioned where important points are brought forward. I desire not only to acknowledge my indebtedness to these authorities for much information on the several sciences, but also to thank those scientific specialists who have so kindly supervised the chapters dealing with their particular subjects.

The reader will, I doubt not, extend to this work the consideration which is generally accorded to first attempts; for thus to group together all the main borderlands is both a novel and a difficult task.

But the subject is a fascinating one, and the effort worth making; and I hope that at any rate this monograph may stimulate abler writers to produce a better book on this important aspect of science.

A. T. S.

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PART I
THE LIGHT

“ Hark ! ” cried the priest of old.
“ Within mine ear God breathed the hidden word.”
Men came and listened, whispered, shook their heads :
“ He hath not wholly heard.”

“ Stay ! ” cried the grey-haired sage.
“ Within my mind the plan laid out I see.”
His fellows drew around. “ Not so,” they said.
“ He hath not found the key.”

“ Here ! ” cries the latest age.
The atom breaks, and life gives up her tale.
“ Is the soul naught ? ” the world-worn spirit sighs.
These men must also fail.

“ Lo ! ” wise men cry, or stand
Like children picking pebbles on the shore.
“ God of our fathers, give us still Thy light,
And when that fails, give more.”

ANON.

THE BORDERLANDS OF SCIENCE

The Vision: Introductory

FOR many reasons it is impossible to represent pictorially the concept presented by our title; we shall therefore endeavour to give a word-picture of it which, it is hoped, will remain vividly before the reader as he peruses the various chapters of the book. A lively imagination is a great help here, and I think it should be possible, if anyone takes the pains, to get a clear presentment of what I mean from the following sketch.

Let us, then, try to picture to ourselves a solid disc —in shape like a watch—of vast but still limited extent, which comprises all things that exist—not merely things in heaven and in earth, but all that is concrete or abstract in the universe, everything, indeed, that the senses can grasp or that the mind can know.

The centre of this vast disc is God, the first great cause (though Himself uncaused), dwelling in perfect light, in direct contact with every cause or origin; the Creator of all things, material or spiritual, concrete or abstract.

We must next picture this gigantic disc divided into segments by radiating lines from the centre to the circumference; each region representing some one special science—of which there may be a hundred or more, either concrete or abstract—the whole of them, as we have seen, absolutely centring in unity. For here, at the centre, is the ultimate cause or origin of all that is included in each separate science, so that the goal of all human knowledge, abstract or concrete, is in touch with the Light itself, although to scientists at the circumference, who use only their own lights, it may appear to be in impenetrable darkness.

Each segment of the disc, or science, commences in the centre with the cause or origin of its subject-matter, succeeded by all its subsequent developments as it approaches the circumference, where it displays its best-known and most superficial phenomena.

It is here that the scientists take their stand in a crowded circle all round the disc, each group busily engaged with its own particular science, and patiently and eagerly studying, by means of the five or six senses at their disposal, these phenomena that lie at the circumference.

Let me here pause for one moment, trusting that my readers have followed me thus far; that they may see plainly depicted before their eyes this vast disc, centred in divine light and surrounded by scientists; the disc itself embracing the whole range of human knowledge, divided into its separate subjects or sciences.

Now to go a little farther. The scientists proceed to explore the disc before them by the light of their own reasoning powers. Not one of their minds, however, can get into direct contact with the phenomena before it, but is able to examine them only by means of the feelers which each mind possesses—commonly known as the senses. These feelers form the only contact between man and the unknown universe around him; and he judges of all things solely by the light of the messages they bring him. Of course, there is the further help of that central light which illumines those dark places which lie beyond the reach of such feelers; but we must not forget that the students are of two classes—those who use this light, and those who do not.

Scientists had not proceeded far in their investigations before they discovered in each section of the mighty disc three regions—the known, the borderland or partly known, and the unknown. For a long time Science hoped to penetrate as far as the unknown centre, which consists, we see, of ultimate causes and origins; but it found, after prolonged efforts, that to try to illuminate the dense obscurity of origins with the lights at its disposal was to attempt the impossible.

Nowadays nothing irritates a strict scientist more than to be asked for the origin or ultimate cause of anything; and the querist is soon informed that such a subject forms no part of the scope of science, which now confines itself solely to phenomena—the "effects" or "results" revealed by the senses to the mind. The physical realist, indeed, believes that the one and only road to knowledge is that which leads through the investigation of external phenomena; all other knowledge, being to him unprovable and more or less mixed with doubt, seems untrustworthy. These difficulties we will examine more fully when we come to treat of the purpose of science.

At this point our circumferential scientists make a further discovery, as they progress in their various sections and become aware of the converging lines on which all scientific investigations (at first unknown to themselves) are moving.

Besides the ordinary scientists, there is a band of scientific philosophers who walk round and round the whole disc, surveying and examining the labours of all the different sections. They work at none, but are cognisant of all; and to them is given first that comprehensive purview which recognises that all the workers are drawing nearer together like the spokes of a cart-wheel: so that, as they progress, a central unity is not only postulated but proved; becoming, in fact, a necessity of thought no longer questioned, although it may be that there is yet no sufficient scientific evidence of its character.

We have, therefore, before us, in the consideration of this disc, three distinct subjects. First, the band of workers at the circumference, and the *human light* by which they reach their successes and their limitations. Secondly, the central power or cause of all, with a consideration of the *divine light* by which it can illumine the unknown, shining as it does towards the circumference—in the opposite direction of the light of the scientists, which shines from without inwards. This latter method of working, speaking broadly and generally, may be called induction, whereas knowledge from the centre outwards is deduction; and we shall see later on how this method is often now used by scientists in order to reach the true synthesis of knowledge. Then, thirdly, we shall consider the middle band of the disc, the borderlands of science, which are but faintly illumined by either the central or circumferential lights, and lie in the *twilight*. We shall investigate, as well as we are able in the compass of a single volume, the contents of this band in the different sections all round the disc.

The book is in two parts: the first comprises all that is in the *light;* the second is devoted to all that is in the *twilight*—the borderlands of science.

We may here take a very brief preliminary survey of this territory. As we have seen, the progress of science is *ab cognito ad incognitum,* the order being from without inwards; the whole territory, we may repeat, including the known, the partly known, and the unknown. The first is that which, viewed from the circumference, is in the light, and is called science; the second, that which is twilight and is borderland; and the third, that which *scientifically* is in darkness and unknown. In this last region there is much which we should know and need to know, but which science now clearly sees cannot be penetrated by its lights. Therefore it has definitely refused to consider this district as within its province at all. In 1880 Dr. Émile Du Bois Reymond enumerated seven special dark spots in this unknown region:

1. The nature of matter and force.
2. The origin of motion.
3. The origin of life.
4. The orderly arrangement of Nature.
5. The origin of sensation and of consciousness.
6. Rational thought and speech.
7. The freedom of the will.

The first, second, and fifth problems he considered to be entirely transcendental and insoluble; the third, fourth, and sixth he held to be capable of solution, though extremely difficult; while with regard to the seventh he remained undecided.

Haeckel considers that the three insoluble problems are settled by our conception of substance. The three that are difficult are answered by the modern theory of evolution; while the seventh and last is a pure dogma based on an illusion.

All this is very unsatisfactory, and, indeed, as we have seen, is not within the province of science at all.

We are compelled, therefore, with regard to the unknown, to look for light to the First Cause in the centre; and the unknown, though, as we have seen, scientifically in darkness, when illumined by revelation becomes a region of certainty, like the circumferential region of the disc lighted by science. The borderland alone remains a region of possibilities and probabilities.

CHAPTER 1

Definition of Science, Philosophy and Art

"Science," says Dr. Whetham in the "Encyclopædia Britannica," "in its broadest sense is synonymous with learning and knowledge." In general usage, therefore, it may be defined as the ordered knowledge of natural phenomena and the relations between them. This is sometimes called natural science. There is also abstract science, for science covers all ranges of knowledge.

Science is therefore not simply knowledge, but systematic knowledge as opposed to loose, popular knowledge; in other words, true knowledge, or the real relations of phenomena and facts to each other. All origins are, as we have said, now carefully excluded; there is no attempt to study anything but effects as distinct from causes, these latter being presumed to lie outside the sphere of true science.

Science is really the higher development of common knowledge. There is such a thing as unscientific knowledge, which simply means the result of elementary impressions on the senses. This is, of course, the first stage of all science, for we only know anything through the senses. The knowledge thus obtained is classified and continually verified by experiment, so as to form an orderly and intelligible syntaxis of our own perceptions. "Syntaxis," I may say, means the process of mental arrangement of ideas, or the sequence of reminiscences. The syntaxes of science have not been immutable, but have often been accepted at one time and rejected at a later period as false.

The field of science comprises the whole range of phenomena, material and spiritual, and cannot be limited to the phenomena of matter, as though no knowledge of any kind that is not attained through the five senses had a real existence. Those sciences that deal with abstract and psychical phenomena are just as real and true as the natural sciences; there can be no doubt, indeed, that they are often the more important, though in their case experiment is far more difficult and research more arduous.

Natural science has to do mainly with the intellect, as distinct from the emotions or the will. Its principal tools are sense-perception, induction, and rational intuition.

Science is not philosophy, although we shall have much to do with scientific philosophy in the following pages. Cicero indeed defined philosophy as the science of things divine and human; Descartes, as the science of things deduced from first principles; and Leibnitz, as the science of sufficient reasons.

So far we have only described science in very simple terms, but the following definitions are of a more abstruse nature. "Science," says Romanes, "is thought, having exclusive reference to the proximate; and explains natural phenomena by the discovery of natural causes." According to Sir William Hamilton, it is "a complement of cognitions having in point of form the character of logical perfection, and in point of matter the character of absolute truth."

Science is a form of truth coextensive with the universe: it first of all attacks what impinges on the senses in the matter of natural phenomena, and then, in the range of the abstract, those points that the mind first grasps as the most obvious.

It is for this reason that in our mental picture of the disc we have represented the scientists as grouped round its circumference (the region of the obvious), although, of course, all seek to penetrate as deeply as possible into their respective subjects.

Prof. Karl Pearson * enumerates the following points with regard to science:

1. The scope of science is to ascertain truth in every possible branch of knowledge; there is no sphere of inquiry which lies outside the legitimate field of science; to draw a distinction between scientific and philosophic fields is obscurantism.

2. The scientific method is marked by the following features: (*a*) Careful and accurate classification of facts and an observation of their correlatives and sequences. (*b*) The discovery of scientific laws by the aid of the creative imagination. (*c*) Self-criticism, and the final touchstone of equal validity for all normally constituted minds.

3. The claims of science to our support depend on: (*a*) The efficient mental training it provides for the citizen. (*b*) The light it brings to bear on many social problems. (*c*) The increased comfort it adds to practical life. (*d*) The permanent gratification it yields to the æsthetic judgment.

We must remark here that this requirement in 2 (*c*) of "normally constituted minds" rather begs the question, for many scientists really refuse to regard any mind as normal that does not accept their conclusions. Moreover, we cannot agree with this author's denial that the fields of science and philosophy are distinct. They may not be always easy to distinguish, for both, in a sense, pursue the same methods, though their rôles are entirely different.

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* "The Grammar of Science," by Karl Pearson, M.A., F.R.S. 2nd Edit., 1900.

If one may venture on a crude parallel, one might compare science to the gold diggers in the Rand or in Australia, and philosophy to the great brokers and financiers with offices in London. The former do all the hard work with the pickaxe, the lantern, the blasting powder, and the elaborate crushing and grinding mills, to endeavour to extract the golden ore of pure truth from the complex mass of rubbish. When this is accomplished the work of science proper is done. Then philosophy steps in, and appraises and values and uses for the benefit of the age the gold produced.

The illustration is not very exact, but, rough as it is, it may be of some service.

Philosophy has to do with facts as truly as any of the sciences, but it does not accept the facts until they have already been classified and generalised by scientists; and is, therefore, properly defined as the science of the sciences. It is as distinct from other sciences as the general is distinct from the special; it deals only with truths already established, which it has been the province of science to discover.

We must ever remember that scientific truth, however well established, only amounts to probability; and never, with rare exceptions, to absolute truth.

Prof. Broda remarks: " The most indefinite of Kant's *obiter dicta* is that philosophy only deals with certainty, not with probability. So far is this from being the case, that to many philosophical questions about the nature of reality no answer except one in terms of probability can be offered."

As we have seen, the distinction between science and philosophy has become of late years very difficult. Science is ever encroaching; metaphysics and philosophy are continually losing ground to it, so that modern science often now aspires to be a philosophy, and not only to furnish the materials but to dictate the principles and methods and laws for every department of life. Thus science, nowadays, is not content with digging the gold in Africa, but has taken an office in the City, and promulgates laws and dispenses the gold, instead of leaving it and its finance to philosophy.

Speaking in modern terms of the value of science and scientific philosophy, Stanley Jevons well remarked: "The value of science is, of course, very high, while the conclusions are kept within the limits of the data on which they are founded; but it is pointed out that our experience is of the most limited character compared with what there is to learn, while our mental powers seem to fall unfortunately short of the task of comprehending and explaining fully the nature of any one object. I draw the conclusion that we must interpret the results of scientific method in an affirmative sense only. Ours must be a truly positive philosophy, and not that false negative philosophy which, building on a few material facts, presumes to assert that it has compassed the bounds of existence, while it nevertheless ignores the most unquestionable phenomena of the human mind and feelings." *

With regard to art, the distinction fortunately still remains clear. Art is practical, science is speculative; art is doing, science is knowing. Most arts are prior to their related sciences; art is the parent rather than the progeny of science; the arts of the Middle Ages existed long before their sciences. Science gives us principles

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* "The Principles of Science," by W. Stanley Jevons, M.A., F.R.S. 1874.

while art gives us rules. In art, truth is the means to an end ; in science, it is the end itself. Art often precedes science, as we have seen, but no art can reach a high degree of perfection unless it is grounded on its science. Arts are industrial, æsthetical, or ethical ; the third group includes law, medicine and divinity.

Science has, of course, a larger kingdom than art. Both have their laws, but while those of science are mainly inductive, those of art are largely deductive. Finally, I think we may say with truth that art has principally to do with instinct and intuition, science with reason.

CHAPTER II

The Character of Science

Mr. Balfour points out that the subject of the natural sciences is that world which is revealed to us through perception, and that here only are we on firm ground.

But the investigation even of this world of mind and matter is limited, for science does not concern itself with the ultimate basis of reality, which is the province of metaphysics, and there is no need for natural science to solve metaphysical problems. So long as phenomena are studied thoroughly, and are of use to man, and enlarge the sphere of his knowledge, we need not ask whether any reality underlies them.

Science, however, cannot be limited, as by Haeckel, to the facts of material experience. So to limit it is irrational, for science has to do with all the facts of human perception, and not simply with those of any particular class.

The mechanical aspect of nature is, no doubt, that which first engaged scientific inquiry, for it gives us a fuller view of phenomena than any other at present known. It is when it is confined to and entirely characterised by this, to the exclusion of all higher views, that, as R. L. Stevenson says, " Science writes about the world with the cold finger of a star-fish ; it is all true, but what is it when compared to the reality of which it discourses ? "

As it advances, however, science cannot limit itself to phenomena, for, as Whewell well points out, two things are requisite to it, facts and ideas, and the two must harmonise. The fatal defect of Greek philosophy was that the ideas did not agree with the facts, and this, of course, is destructive, as facts must ever come first. Ideas very soon multiply and eventually come to be called laws, which laws are the dogmas of science.

Primarily, however, science is gnostic, and rests on facts and not on dogmas. It is built up on facts as a house is built of stones ; but it is no mere heap of stones or facts, but facts as arranged by mind, and forming thus a basis for generalising into laws.

It is clear, therefore, seeing that natural facts indicate effects and not causes, that these effects or phenomena are the building material of science.

Science not only gives us exact knowledge, but indirectly the effect of pure science on practical life, as Karl Pearson has pointed out in "The Grammar of Science," is enormous, "in the appreciation of evidence, in the classification of facts, in the elimination of bias, in all that may be termed exactness of mind."

It is also most stimulating to the observing faculties, for what at the instant of its first appearance seems to be only a sequence of purely theoretical interest often becomes the basis of some further discovery, which may in the end profoundly modify the conditions of human life. It is impossible to say of any result of pure science that it will not be the starting-point of wide-reaching technical applications.

In considering the character of science, we must never forget that the knowledge we possess is only intelligible and true to human beings. All science is in a sense anthropomorphic, and consists only of what nature appears to us to be through the media of our own senses, which are the sole means of apprehending the phenomena with which we come into contact. Our human mind takes cognisance of that part of the great stream of knowledge with which we are in immediate touch. Its source is still hidden, and its destination unknown to us, yet we may surmise much regarding both.

In its main features science is so extremely modern, and so very rapid in its prodigious growth, that much of it, as we shall find, is still in a nebulous or borderland condition, and is in the process of crystallising. Moreover, it is growing faster than ever, and no science has yet reached the limits of its development. In the last three centuries almost every science has undergone a revolution, and it is believed that the sum total of scientific knowledge was increased more during the nineteenth century alone than during all preceding time.

Compared with the astounding progress in physical science, and its practical application, our entire social and moral organisation remains in a state of barbarism. The extreme scientific skill used in the Great War, combined with its utter immorality, is ample proof of this. The fact is, there is no essential alliance between science and morality at all.

Striving at first after too much, science made many failures, and much has been said about its bankruptcy, as though it had gone to pieces in failing to accomplish what it had no ability to perform. But all depends on what we mean by science, and what we expect from it.

It is certainly bankrupt if it strives to take the place of art, literature, and religion—but not if it keeps to its own sphere. But though it must not and cannot take their place, it certainly has far more relations with all three than at first appears, or than many seem inclined to admit.

Every true scientist must assume that the universe is the product of mind, and not of blind chance. The reign of law which every science soon recognises necessitates intelligence and purpose. The reason that the scientist regards the cosmos as comprehensible by thought is because it is the product of thought. "The materialistic position," says Huxley, "that there is nothing in the world but matter, force and law, is as utterly devoid of justification as the most baseless of theological dogmas."

No science, indeed, would be possible unless a purposive order were assumed, and it has been well said by Stanley Jevons that "science arises from the discovery of identity amidst diversity."

In modern times nothing has been more striking or more helpful than that the march of science is ever towards unity and simplicity; for scattered facts soon become strangers to each other unless marshalled by induction and deduction into synthesis.

Each of the sciences has its own ideal, but the goal of universal science is the discovery of one ultimate principle explanatory of all observed phenomena.

The present view of science, though not avowedly teleological, is certainly implicitly so; and though science and morality are not directly connected, the difference between the physical and the moral universe is rather in degree than in kind. It is true that many of the problems to which the discovery of purpose in the universe gave rise, as well as the old scientific theories of the universe, no longer exist; but teleology remains unshaken.

One cannot write on the character of science without considering what one means by scientific truth. We must at once say that it is not as a rule absolute truth, for science is not rightly conceived when it is limited to that knowledge which can be formulated by mathematics or verified by experiment. Science is no foe to common sense nor to faith, and imagination as well as analogy is essential to it.

None of our knowledge, then, is absolute; it is all relative, and consequently partial and incomplete. It is not, therefore, on absolute truth that science rests its character, but on the inherent and tested probability of its generalisations of facts.

The real claim science has for a hearing is its reasonableness; on this we accept it, and act upon its teaching, until we see good reason for setting it aside. It is only as we test all things that we learn to "hold fast that which is good."

It is not necessary for science that it be complete or free from error; for if perfection were essential, we should have no science, there being no perfect science in the world. In no sphere of knowledge have all the facts been yet ascertained. "Now we see through a glass darkly" describes the present condition of every science as well as of every human mind.

Naturally this is not freely admitted; and much that is doubtful is dogmatically asserted as truth, with a courage worthy of the Early Church Fathers; for science has its bigots and dogmatists as well as theology.

Let us remember that physical science can never give us any generalisation which is more than probable, and this is true also of all its facts. When I say I see the light of the lamp, or hear the ticking of the clock, I can never be positively certain that I actually do either. What I know positively is that I experience a sensation, and that there is some cause for the sensation; but what this cause is amounts only to probability.

It is true, therefore, though but little recognised, that the facts of physical science have none of the characteristics of positive knowledge; they are always mediate, indirect, and inferential, and our knowledge of them can never be more than probable. Of course there is nothing merely probable in nature itself; the probability exists wholly in our own minds.

This explains much that is puzzling in the statements and subsequent retractations of science, for what is truth can never be disproved; what is probable may be.

We must, therefore, ever distinguish between certainty and probability. Many of the so-called facts of science may be disproved, and have been; but no two certainties ever clashed, and there is no such thing as two contradictory truths. The best that science can do is to displace the uncertain by the more certain, and thus overcome in part, but only in part, the limitations of our ignorance.

Probability is the only basis upon which all inductions rest; for instance, even such a fundamental principle as the law of gravitation, or the proposition that fire burns.

So far we have used the word science by itself to stand for the natural sciences; there are, of course, so-called pure sciences, which consist largely of self-evident truths. Only mathematics and logic start with certain knowledge; all others reach towards it through experiment. Truth that is absolute is far more rare than we think, and it is hardly found outside the scope of revelation.

Practically we live by common sense rather than by pure reason, and the whole of life is a balancing of probabilities. He who will not act save on the lines of positive truth will only have an asylum to live in, for when a man bids farewell to common sense in favour of pure reason, we call him mad. Like Mr. G. K. Chesterton, I have been immensely struck with what may be called the extreme rationality of lunatics. Their assumptions granted, nothing could be more reasonable than their mental processes.

As we have seen, science consists in the acquiring of systematic knowledge; scientists have said that its *aim* is to explain the unknown in terms of the known; that its *object* is to simplify the description of our sensations; that its *goal* is the possession of truth; and that its *hope* is nothing short of the complete interpretation of the universe. Science stands, therefore, for the nobility of truth, for accuracy of knowledge, and for practical use.

Tyndall tells us that men of science have but one idea—to know truth; they have but one fear—to believe a lie; that they have as little fellowship with the atheist who asserts there is no God as with the theist who says he knows the mind of God.

The student of pure science pursues his investigations partly because he derives a certain pleasure from knowing things that he did not know before; the formulation of laws does not in itself content him as an object.

True scientists find their reward in seeing science flourish, and in the knowledge that others devote themselves to develop the practical advantages which accrue from their labours.

Sir John Lubbock (Lord Avebury) says: "Science adds to the interest and brightness of life, and purifies and ennobles the character."

Dr. R. C. Macfie observes: "To maintain that true science is purely utilitarian and material is to have a complete misconception of her dominion and destiny. All related knowledge is the province of science; and if she be wise and deep-seeing science, she walks . . . hand in hand with poetry and philosophy. . . The great achievement of modern science seems to me not so much its mechanical inventions as its rapprochement to philosophy and religion. . . . It has discovered that the objective is merely force, and it has abolished the barrier between mind and matter, so that where such science ends, philosophy and religion may begin." *

Archbishop Temple urged his students to find in their scientific studies the evidence of moral law, and the means of the elevation of their higher nature. "The advocates of science," he says, "urge their claims on the ground of its ennobling nature, its intellectual discipline, its abstract value, and the practical worth of its pursuit to the individual and the nation."

The world, therefore, has not advanced by scientific theories only, but by realities of feeling and doing; for there is a fund of wisdom in the common sense and practical instincts of the common people which philosophy often misses. Science does not destroy the beauty of life, seeing that the full gratification of the æsthetic judgments is one of the chief delights of the pursuit of pure science.

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* "Science, Matter and Immortality," by R. C. Macfie, M.B., C.M., LL.D.

CHAPTER III

Scientific Methods and Laws

THE first thing required to form a science is evidently a scientist; but true scientists are not found everywhere. Certain special qualities are needed—a stern love of truth, an absence of preconception, predilection, and prejudice; a capacity to weigh evidence; ideas, imagination, insight, and an ability to reason soundly and logically, both by induction and deduction. Reason alone will not do; the whole powers of the man must be thrown into the science, and the imaginative and æsthetic sides play their parts in scientific investigation, subordinate though they may be.

The general methods of science are three in number:

1. Intuition and induction.
2. Hypothesis and deduction.
3. The formulation of laws and general synthesis.

We will take the three in order, and in doing so, as the subject is involved, shall not hesitate to repeat ourselves, in order to emphasise the points to be distinguished, and elucidate the whole matter.

1. The primary data of science are not furnished by science itself, but by the mind's own intuition. Before science can classify, it must have material on which to work, and this material in its elementary form is obtained by intuitive conception from observation.

Aristotle says there is nothing more certain in science than intuition. But intuition is not always a safe guide; it is allied to instinct, and instincts are far more reliable in animals than in man, because animals have not the highly developed reason nor the intellect of human beings.

Intuition and instinct may be called the reasoning powers of the unconscious mind. The axioms of Euclid and truth generally are supposed to be known intuitively. But such, again, is not always the case; and we must repeat that in man neither instinct nor intuition is an infallible guide. The difference between the two is not great; but instinct may be described as subjective wisdom, and intuition as the discernment of the objective.

Science proceeds in the reverse way to metaphysics. The metaphysician works downwards by deduction from laws and first causes to effects, but the physicist works upwards by induction from effects and phenomena to laws, leaving first causes severely alone.

Induction at most establishes a probability—never a certainty.

Deduction is the inference of particular from general truths, and often recognises authority and dogma, and establishes its facts by *logic*.

Induction is the inference of general from particular truths; it recognises no authority or dogma, and it establishes its facts by *experiment*. We thus deduce from ideas, and induce from facts.

Synthesis is the combination or product of induction and deduction. It is said that the partial failure of Herbert Spencer's philosophy was due to his lack of synthetic power.

A great danger in science is that of making inductions from insufficient experiments, or basing conclusions on unreliable premises. The inductive and deductive methods of inquiry should go hand in hand, and the combination of experiment with theory and hypothesis is the best for research. These, indeed, include all the methods available, and scientific truth depends upon their right use.

The scientific premises of deduction are the laws and hypotheses framed on observations and experiments. The deductions of science suppose certainties, and if a deduction from a supposed law or premise agrees with induction from experiment, the two meet, as it were, half-way, and the resulting law ceases to be a hypothesis and becomes an established fact, or at least established within the range of scientific probability. Stanley Jevons says that induction is really the inverse process of deduction. There is no doubt that in science the two must work together.

2. The process of deduction is to draw from certain premises inferences that will necessarily be true if the premises be true. Such is largely the special method of mathematical science; but there is no doubt, as the "Encyclopædia Britannica" points out, that the deductive geometry of Euclid (300 B.C.) had an unfortunate influence in unduly emphasising the deductive method, and teaching men to neglect to verify the various deductions by experiment.

We begin to see from all this the part that hypotheses or supposed laws play in the discoveries of science, for though its primary agent is experiment, induction is generally controlled by hypothesis. In other words, induction goes hand in hand with deduction; and the hypothesis framed by induction is a supposition made, from which conclusions can be deduced in accordance with real facts. A scientific hypothesis must not remain so, but be provable or disprovable by facts; if proved or made scientifically probable by facts, the hypothesis is established, and an established hypothesis is called a theory or a law.

Hypothesis is a necessity to the experimenter, and there are three sorts—those that are verifiable and become truths; others which may be of use in fixing our ideas but cannot be proved; and others again, as in mathematics, which are only definitions in disguise.

Every generalisation from facts is an hypothesis. The "Encyclopædia Britannica" remarks that Bacon brought in an almost entire disuse of the deductive method and of hypothesis; but scientific discovery is seldom or never made by the pure Baconian method of simple induction. Phenomena are too multitudinous to be attacked with success without the aid of hypothesis, framed by the use of the scientific imagination; facts are then collected, proved or disproved, and the consequences deduced from the hypothesis.

Within the last century a reaction has been setting in against the empirical procedure of Bacon, and physicists everywhere advocate the use of hypothesis. Stanley Jevons considers that the hypothetical anticipation of nature is an essential part of inductive inquiry, and that it is the Newtonian method of deductive reasoning combined with elaborate experimental verification that has really led to all the great triumphs of scientific research.

The inductive Baconians and deductive Newtonians remind one of the old theological conflicts of Calvinists and Arminians. Each one has part of the truth, but to get the whole, one must combine the two.

Huxley and others who refuse to go beyond fact rarely get so far as fact; for every great step in science has been made by the invention of hypotheses, which often have very little foundation to start with, and not infrequently turn out to be wholly erroneous in the long run. But hypotheses which are erroneous may yet be great helps indirectly in starting other trains of thought, and eventually leading explorers on to the right track. Scientific discovery proceeds very much like gold-mining, which is governed by hypotheses, many of them leading to nothing.

The construction of any valuable theory requires the presence of an intellectual element which is as personal and incommunicable as that which distinguishes the works of great artists. Science in its highest form, therefore, is not opposed to art, being an art in itself; just as, on the other hand, every art is a science. The two are complementary, the one being the knowledge of something and the other the doing of it.

Until one has looked into the matter, no one would believe the part that imagination has played, and does play, in science. Lord Kelvin's smoke rings were a pure effort of this sort; and indeed, disciplined imagination has been at the bottom of all important scientific discoveries. All great scientists have in a certain sense been great artists; for the man with no imagination may collect facts, but he cannot make great discoveries. The imagination, however, must be disciplined and submit itself to the stern logic of facts. The attainment of general agreement is the crucial point at which a subject passes from the realm of conjecture into the territory of fact.

When we watch the fate of most scientific hypotheses, made by our greatest minds, as they pass from a life of active usefulness into the museum of intellectual curiosities, we learn that no man is to be deemed infallible in his theories. Assumed truths constantly disappear, or are modified with the evolution of science.

In "The Principles of Science" Stanley Jevons says: "We may safely accept as a satisfactory scientific hypothesis the doctrine so grandly put forth by Laplace, who asserted that a perfect knowledge of the universe . . . would give a perfect knowledge of all that was to happen henceforth and for ever after. . . . To the view of Perfect Intelligence nothing is uncertain." But this perfect knowledge none have got, and so, with profound wisdom, Laplace well adds: "We must ever remain at an infinite distance from the goal of our aspirations; . . . no single law of nature can warrant us in making an absolute prediction. We must know all the laws of nature, and all the existing agents acting according to these laws, before we can say what will happen." To assume, then, it is added, "that scientific method can take everything within its cold embrace of uniformity is to imply that the Creator cannot outstrip the intelligence of His creatures, and that the existing universe is not infinite in extent and complexity, an assumption for which I can find no logical basis whatever."

3. We pass on now from hypothesis to consider scientific law, which is indeed the ultimate product of science and is established by synthesis. The objects served by the discovery of laws is the economy of thought, and they record in some permanent way the progress of science. These laws of nature are, as we have said, arrived at by induction and deduction.

In their first stage, no doubt, most scientific laws are but working hypotheses adapted to the needs of discovered facts. Much remains to be done before they can be accepted as scientific truths. Experiments are made to verify a theory, which, when established and verified, is said to be a law of nature.

Scientific Methods and Laws

A law of nature is not in itself a fact, but it is a supposition which should account for all or nearly all the facts with which it is connected.

Consider more particularly how these laws arise. Supposing an elaborate classification of scientific facts has been made, what is the next stage of scientific investigation ? Undoubtedly it is the use of the imagination. The discovery of some single statement, some brief formula, a few words which replace in our minds a wide range of relationships between isolated phenomena, is what we term a scientific law. In the scientific world exceptions do not prove rules, but as regards these laws they disprove them. But there is a further semi-unconscious force at work of which we have not spoken, which causes scientists perpetually to be framing laws.

The universe in which we dwell is clearly not the result of chance, and where chance seems to work, it is always our own deficient faculties which prevent us from recognising the operation of law and design. Therefore it is that scientists make laws. We are accustomed to speak of scientific law as of something universally valid —that is, something which is true for all men. Some, indeed, assert that natural law is independent of the human mind altogether, and is of the nature of absolute truth. But natural laws are only true to a certain type of perceptive faculty, namely, that of normal educated adults ; not to children, animals, or savages.

Law, in the scientific sense, is thus essentially a product of the human mind ; it owes its existence to the creative power of its intellect, and there is more meaning in the statement that man gives laws to nature than in the converse that nature gives laws to man. Scientific laws do not really exist at all before man has given expression to them, for they are related to the perceptions and conceptions of man alone, and are meaningless except in association with these.

The ultimate explanation of every word that we use is the sense-impression it conveys; and a natural law has been defined as a description of the sequences of sensation.

The discovery of law is therefore the peculiar function of the creative imagination of man; but this imagination must be a disciplined one: it must appreciate the whole range of facts; it must be tested in every conceivable way by the discoverer, until he is certain that the imagination has not played him false. Self-criticism is an evidence of the scientific use of the imagination, which is the very life-blood of science.

The announcement of a new law to the scientific world is an event of some importance, and, as has been well expressed by an observant scientist, "the same befitting solemnity, the same sepulchral dignity again clothes the dispenser of new truths as of old shone round the prophets with the oriflamme of truth."

Scientific laws are continually in advance of abstract truths, and though often cancelled and altered, a steady advance of truth is to be observed behind them. A scientific law may be true in the main, and yet not always so in detail. We are constantly finding vexatious exceptions, and modifications have to be made in what we began with as an absolute law.

For instance, Stanley Jevons points out that one result of the progress of science is to show that qualities supposed to be entirely absent from many substances are really present, only in so low a degree of intensity as to escape notice in the process of deduction. We are repeatedly learning, in spite of scientific terms, that there are no substances absolutely opaque, non-conducting, non-electric, non-elastic, non-viscous, non-compressible, insoluble, invisible, or non-volatile; each is only a matter of degree. Faraday and Tyndall have shown that it is doubtful if there be any substance wholly devoid of magnetism. They have also shown that even the best conductors, such as pure copper and silver, offer some resistance to the electric current; while the best insulators, such as indiarubber, allow of some conduction.

Turning to another result of the progress of science, we find that the reign of law, the necessity of uniformity of natural forces, has not uncommonly been interpreted as involving the non-existence of an intelligent and benevolent power capable of interfering with the course of natural events. Fears have been expressed that the progress of scientific method may result in dissipating the fondest beliefs of the human mind.

In reply to this, Stanley Jevons, in "The Principles of Science," expresses his strongest conviction that "before a rigorous logical scrutiny the so-called reign of law will prove to be an unverified hypothesis, the uniformity of nature an ambiguous expression, and the certainty of our scientific inferences to a great extent a delusion."

Nevertheless, the conception of law is absolutely essential to science, for it alone transforms the world from chaos to cosmos. Moreover, as they multiply, we begin to see that the laws of Nature form a unity, a totality, a whole; that they are all reasonable, and the product of some infinite reason or wisdom.

Stanley Jevons must not be understood to deny the reign of law, but rather the deduction drawn from it by some scientists. He says: "A law of nature, as I regard the meaning of the expression, is not a uniformity which must be obeyed by all objects, but merely a uniformity which is, as a matter of fact, obeyed by those objects which have come beneath our observation. There is nothing whatever incompatible with logic in the discovery of objects which should prove exceptions to any law of nature. Perhaps," he says, " the best established law is that which asserts an invariable correlation to exist between gravity and inertia, so that all gravitating bodies are found to possess inertia, and all bodies possessing inertia are found to gravitate ; but it would be no reproach to our scientific method if something were ultimately found to possess gravity without inertia. I demur to the assumption that there is any necessary truth even in such fundamental laws of nature as the indestructibility of matter, the conservation of energy, or the laws of motion. The laws of nature, as I venture to regard them, are simply general propositions concerning the correlation of properties which have been observed to hold true of the bodies hitherto observed." *

It may, however, be stated as probable that scientific laws found true for this world have, so far as they have been tested, been found to extend without change throughout the universe.

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* "The Principles of Science," by W. Stanley Jevons, M.A., F.R.S. 1874.

CHAPTER IV

The History and Classifications of Science

BEGINNINGS are always interesting, and not least so in the history of scientific discovery. We will give here a few detached notes on this subject, showing its progression in various ages. We shall thus get great light thrown on the shifting nature of the scientific borderland.

Empedocles (450 B.C.) regarded the elements as four —earth, water, air, and fire; he also conceived the first idea of the Greek atom, described at a later date by Lucretius; he had no idea, however, of its chemical combination into gases, liquids, or solids.

Anaximenes first discovered the rotation of the heavens round the pole star.

The Pythagoreans regarded the earth as a sphere revolving round a certain central fixed spot; but it was Aristotle (280 B.C.) who believed the sun was larger than the earth, and looked upon it for the first time as the central body.

The history of astronomy, however, goes back through all the ages of man; it was the first of all the sciences; it flourished in Babylon, and was there traced back to Seth, the son of Adam, the supposed author of the zodiac.

The science of mechanics began with Archimedes (280 B.C.). According to Myers, Socrates originated the idea of the material sciences; but Swedenborg first attempted to introduce a science of the unseen, and his most illustrious follower in this particular direction has been Sir William Crookes. Socrates expressly excluded from his idea of science even such matters as the movements and nature of the sun and moon. Comte took a wider view, but still limited science to the solar system. At the present day it would be extremely rash to exclude the stars or any spiritual and mental phenomena.

At the end of the Middle Ages Coprates (1500 A.D.) revived the heliocentric theory; and with the Renaissance science generally advanced.

In 1564 Galileo founded the science of dynamics; while Sir Isaac Newton gave us the law of gravitation. In 1850 Stokes enabled us better to ascertain the position of the heavenly bodies; while Darwin brought out the value of the struggle for life in his theory of evolution. Of late years (as the "British Encyclopædia" points out) his ideas have been largely superseded by De Vries, Bateson, Mendel, and others, by the discovery of discontinuous mutations which arise spontaneously, pointing to the conclusion that in nature such sudden leaps may be a normal course of development.

Descartes aimed at creating a complete system of human knowledge from the earliest times. The science of cosmogony began with Kant.

The more science advanced, the greater opposition it encountered, often in the highest places. For instance, Lavoisier, when he analysed the air and discovered that it was composed of oxygen and nitrogen, was furiously opposed by a member of the Academy of Science, who regarded it as an element. Lavoisier himself believed that nothing more remained in the world of science to be discovered in his time; he also presented a learned report to the Academy showing that meteoric stones could not fall from the skies. When one was seen falling it was described as an eruption in some unknown region. Most discoveries and advances in science met with similar opposition.

Even in 1878, when Edison's phonograph was introduced to the Academy of Science and the machine began to speak, one of the members rose up and shouted: "Wretch! we will not remain dupes of a ventriloquist." The same member, six months later, declared, after close examination of the machine, that he could find nothing in it but ventriloquism, and that it was impossible to admit that mere metal could perform the work of human phonation, so he decided that the phonograph was nothing but an acoustic illusion. To some extent we may say that the fact that several different sounds are produced simultaneously by the vibrations of the point of a steel needle in the gramophone is still in a borderland position, at any rate as regards its exact explanation.

Of course, all down the ages science was considered very inferior to literature and art. It is true that science triumphed over literature in Cambridge in 1662, and the predominance of mathematics over classics survives there to this day; but in general it was not so until quite recently.

As we consider the history of science we are struck with its long record of forsaken faiths, bygone beliefs, fallacious facts, and treacherous theories. Many beliefs are still cherished which have no better foundation than several of the extinct pre-scientific ideas. In years to come these will serve, doubtless, as curious and instructive examples of states of imperfect mental evolution in the past; and wiser descendants will wonder how rational beings could ever have been so irrational as were their forefathers.

There are few exploded errors which did not at one time appear absolutely reasonable to men of high intellectual powers. Again and again science has confidently put forth a theory which only a few years later had to be replaced by some other hypothesis better adapted to the science of its time ; it is thus that science mounted on stepping-stones of its dead self to higher things. There is practically no branch of science which has not been revolutionised in the course of time. Even in these early days of the twentieth century much that was science in the nineteenth century is now back in the borderland, and vice versa.

Until a hundred years ago everyone accepted the doctrine of spontaneous generation ; science just now believes that it is not true. How exploded, again, are the supposed scientific facts of Huxley's Bathybius and the *Eozoon Canadense* of Dawson, and the claim for Koch's tuberculin that it was an infallible cure for tuberculosis ! Even twenty years ago men generally were much more positive than now, and a famous book was then written on the bankruptcy of science in which it was proved to the author's satisfaction that everything that was essential and possible was known, and all that remained was mere detail. Immediately afterwards came the discovery of electro-magnetic waves, the electric furnace, the X-rays, radium, the new gases in the atmosphere, and the liquefaction and solidification of hydrogen ; so that where before there was firm ground there is now nothing but shifting sand.

The last century began with the atom, and the result is most of the machinery of civilisation as we have it. This century begins with the atom within the atom, and the civilisation of coming years may be eventually transformed into a character of which we have now but the barest glimpses, by advances in the use of electricity.

At the close of the nineteenth century the unchanging, apparently eternal chemical atom, which bore all the stamp of a manufactured article, was the ultimate basis of physical science. On this was built a scheme of a universal mechanism moved by a limited amount of energy which could be neither increased nor diminished; but all the time the atoms themselves were silently waiting for someone to find a successful hypothesis which would explain them into contortions of ether! It seemed in those days as if the main outlines of physical knowledge had been laid down once for all, and that the task of succeeding generations was merely to fill in these outlines and carry them to perfection. In the same way a new system of thought (evolution) spread to the domain of biology, and was accepted as an adequate explanation of some of the deepest problems of life. Many of its original dicta are now exploded or generally questioned.

The successive oscillations of thought in biology from mechanical to vitalistic theories has been another of the features of the progress of science. In this we do not refer to the well-known fact that the same object may scientifically be regarded from many points of view. To a psychologist, for instance, a nerve impulse is considered in relation to thought; but physiologically, in connection with its material structure.

Examples of oscillation of thought can be seen, as Karl Pearson points out, in the division between the real and the unreal, and again between the real and the ideal, which is less distinct than many may think. For example, the planet Neptune has passed from the ideal to the real, but the atom is still ideal. The ideal passes into the real when its perceptual equivalent is found; but the unreal can never become the real.

We must remember in this survey that only now are we in possession of the tools which are needed for profound scientific research. When we consider what the ancients discovered, practically without any exact instruments, we see how vast are our advantages to-day in connection with the progress of science. We now have a balance that will weigh $\frac{1}{500000}$ of a milligramme; the slide-rule is a marvellous invention whose almost magical powers are too little known except to engineers and mathematicians; the steam-engine itself, once a marvel, is now merely regarded as a passing link of transition between the water-wheel and the dynamo; chemically pure iron is only now produced for the first time, as also solid carbonic acid gas, solid hydrogen, and liquid air. The ultra-microscope enables us to observe corpuscular movements and other marvels never seen before.

There is no doubt that the ignorance of science is extending more than its knowledge; but it cannot allow any fixed barriers to be erected between the two, for it is ever moving on, and its borderland is ever shifting; and probably nearly all that is so described here will have passed into science in a few years' time.

I should like, before leaving this part of the subject, to refer with admiration to the extreme caution and patience of scientists, which gives such great confidence in their reliability, and such a general and well-deserved authority to their discoveries. However these may be superseded eventually, as all may be, with the perpetual advance of knowledge, they constitute an undying witness to the faithful work of their authors.

Copernicus was a priest who lived a calm, peaceful and retired life, circulating all his wonderful ideas by conversation, and not attempting to put them into writing until he was 70 years old. Faraday writes: " The world little knows how many of the thoughts and theories that have passed through the mind of the scientific investigator have been crushed in silence and secrecy by his own severe criticism and adverse examination, and in the most successful instances not a tenth of them has been realised." Darwin, speaking of the dawning upon his mind of natural selection as the key to the mystery of the origin of species, says: " Here then at last I got a theory by which to work; but not until four years after this did I venture to write a brief abstract of it in pencil in thirty-five pages, and not until twenty years after did I publish my thoughts." In like manner, Newton laid aside for nearly eighteen years a demonstration touching the gravitation of the moon, until he had supplied a missing link in his reasoning. Even in this restless age the same patient spirit is still to be found among scientists.

Passing on to consider the classifications of science, the reader will recall the large circular disc composed of all things in heaven and on earth, surrounded with the busy band of scientists, all exploring their segments in the direction of the centre by the lights of reason, experiment, and theory, and thus ever learning more and more of truth concerning them.

He will also recall that these busy explorers, diving deeper and deeper, became slowly sensible that the farther they went the nearer they got to each other, so that none could shut out the idea that all tended to eventual unity.

Further, he will remember how, greatly daring, we ventured to assert that this central Unity was in itself the First Cause of all, the Unknown and Unknowable of Herbert Spencer. We may go yet farther and say that this Central Unity is also the God of revelation—using "revelation" in its widest sense—who, by another light, altogether different from that of reason, illumines from the centre those very parts that the lights of science now everywhere confess they can never reach.

Lastly, the reader will remember that between the two lies that borderland of twilight which is the chief subject of this book. Our concern just now, having considered a little what science is in its essence, in its relation to philosophy, metaphysics, and art, in its character, in its methods and laws, is to gaze round the vast circle of all that exists, and find out how the whole disc has been divided for purposes of exploration.

Human knowledge may be separated into three regions:

1. The physical sciences, dealing with inanimate material.
2. The organic sciences, dealing with organic bodies and living things.
3. The abstract sciences, dealing with problems of the mind.

It is interesting to notice that the third class—the abstract sciences of the mind—is the oldest of the three. Of the seven sciences known to Aristotle and the great army of schoolmen, six were abstract—music, logic, arithmetic, geometry, grammar, and rhetoric; astronomy alone being partly physical.

Nowadays the divisions are wellnigh gone, but we may still distinguish the three classes of which we have spoken.

The first division, the science of the inorganic, may now, since the days of the ultra-microscope, be divided into molar and molecular physics; the former includes all that deals with matter, movements and energies *en masse;* the latter is an attempt at an ultimate analysis, and includes not only matter, but heat, light, and electricity.

It is of interest to note that physical science in Whewell's time included mechanics solid and fluid, acoustics, optics, thermotics (heat), geology, atmology or the science of the air, electricity, mechanics, chemistry, mineralogy, botany, zoology, physiology, anatomy, morphology, and ontology.

Comte, in his Positive Philosophy, restricted the sciences to sociology, biology, chemistry, physics, astronomy, and mathematics; his mistake was in limiting the sciences to natural philosophy, ignoring psychology and all its related sciences.

Another division, by Prof. Hoffmann, gives five physical sciences: astronomy, geology, physics, chemistry, and biology; three psychical sciences: psychology, sociology, and theology; and six philosophical sciences: logic, mathematics, æsthetics, ethics, economics, and politics.

The best and most modern list gives five abstract sciences: mathematics, physics, economics, ethics, and politics; and six concrete sciences: chemistry, astronomy, geology, biology, psychology, and sociology.

All these various and contradictory lists simply show that no general classification has been arrived at or agreed upon.

On the other hand, from his own standard, Herbert

Spencer classifies mechanics, physics, chemistry, astronomy, and geology as physical sciences; biology, sociology, and psychology as psychical sciences; and logic and mathematics as philosophic sciences.

Many suppose that the different sciences have so completed our knowledge of the material world that little remains to be discovered; but the truth is that all the sciences together have but explored an infinitesimal fraction of the whole.

Mathematics, physics, chemistry, and biology are specially called pure or fundamental sciences, while astronomy is as it were the parent of all the physical sciences, being the oldest. Mathematics is perhaps the most exact and certain science, and yet, as we shall see, it, as well as the rest, has a borderland of its own, where the truth is not fully known.

No good purpose can be served by attempting a complete enumeration of all the sciences, which may number a hundred or more, and many of which, such as cosmogony and geology, overlap. Moreover, new sciences are being added almost every day.

What we do need to bear in mind is that the sciences, so far from being limited to the material, must include the abstract and spiritual; and not only so, but that in molecular physics the material itself is fast disappearing from our gaze, and we seem likely to be left face to face with the spiritual only.

Further, we may recall what has been said about the drawing together of the various sections of science, and the prospect they hold forth increasingly of ultimate unity. All this tends to lessen the desirability of any divisions.

Science used to be minutely classified and subdivided; but there is now increasingly a tendency for all varieties to coalesce, and many lines of demarcation have already been obliterated. Geology has now become allied to physics, chemistry to biology; while no one can say whether radio-activity is chemistry or physics, or even whether sociology is biology or economics. All is tending to unity.

CHAPTER V

The Limitations of Science

We saw in the last chapter how science has only lately come into the possession of proper tools wherewith to prosecute its final researches. It is not too much to say that a fresh world is now being revealed to man for the first time by the ultra-microscope, which shows the movements of molecules, by the discovery of the X- and other rays, by radium, by the spectroscope, by advances in photography, and by other means. There is no doubt that our scientific tools will still continue to improve, and that we shall yet possess instruments of a degree of delicacy and precision of which at present we have no conception.

But while there is a great advance in apparatus, what must we say about the man behind the microscope ? We see no prospect that the narrow limitations under which he works will be extended, or that his mental capacity will be improved, as his instruments have been. There is no sign of the advent or evolution of a superior man with a greater brain and wider intellect than the giants of the past ; the shortness of human life, of course, militates against any great individual development ; and modern scientific opinion on the whole is adverse to the possibility of the transmission of acquired knowledge from parents to children, so that to a great extent each one has to start afresh.

Man's limitations are very many. He has many physical defects and weaknesses that hamper and limit him at every turn; he cannot exist at all save within very narrow limits of heat, nourishment, and rest; deprive him of these, and he dies. His span of life is so brief that he has not time to digest the information he acquires. Not only so, but his observation cannot be even prolonged for days together, for he must spend nearly half his time in sleep. Moreover, during a large part of his short span of life his powers either have not matured or are decaying. The wonder is that with such physical limitations he should accomplish what he does.

Another great difficulty is that his scientific results would be of much more value were it possible for us to believe that his discoveries and laws are facts — are really of the nature of absolute truth. But such are his further limitations that it is extremely doubtful whether anything he advances scientifically is true to anyone but himself, and probably to some (but not all) of his own species.

It seems that he has two limitations which are so great and so far-reaching that it is impossible to believe that any of his discoveries are necessarily facts or are absolutely true, though no doubt most of them are probable. What are these two great limitations which handicap the scientist every time that he works, in addition to his ordinary physical disabilities? They are his senses, and the quality of his mind.

First as to his senses, Prof. Karl Pearson asks, in "The Grammar of Science": "How close can we get to this supposed world outside ourselves? Just as near but no nearer than the brain terminals of the sensory nerves. We are like the clerk in the central telephone exchange, who cannot get nearer to his customers than his end of the telephone wires. Of that real universe outside himself he would be able to form no direct impression; the real universe for him would be the aggregate of his constructs from the messages . . . in his office. . . .

"Very much in the position of such a telephone clerk is the conscious *ego* of each one of us seated at the brain terminals of the sensory nerves. Not a step nearer than those terminals can the *ego* get to the 'outer world.' . . . Of the nature of 'things-in-themselves,' of what may exist at the other end of telephone wires, we know nothing at all. But we may think, 'I not only see an object but I can *touch* it.' . . . . The sense impression that you call 'touch' was, just as much as sight, felt only at the brain end of a sensory nerve. . . . All you have been doing is to employ one subscriber of your telephone exchange to tell about the wire that goes to a second, but you are thus just as far from the outside world as ever."

Literally, indeed, our five senses themselves never deceive us, for the actual knowledge they give us is positive; it is our inferences from it that are always fallible, and can never be more than probable; even the experiments of the laboratory, and the most accurate instruments we have, are unable to give us absolutely certain results; there is always the possibility of three mistakes—in the instrument, in its message to us, and in our understanding of it.

Speaking as we do of the senses themselves, and of the brain that interprets their vibrations, as one, it was early seen that the senses are in themselves untrustworthy, yet it has been shown (especially by Hobbes and Locke and Hume) that no basis of scientific knowledge other than sensation is possible.

No doubt *experientia docet*, and through our experience we have learnt now to discount the testimony of our senses.

We know there is no such thing as heat and cold in the universe; only motion more or less rapid. Sensation and reality are two different things. Our senses only enable us to feel a very small number of the movements which make up the life of the universe; for instance, between the 36,000 vibrations per second which constitute the highest note we can hear, and the four hundred billion vibrations per second which constitute the lowest colour we can see, we perceive nothing at all. The limits of our spectrum are not in the sun that shines, but in the eye that perceives his shining. Beyond each end of the prism are ether waves of which our retina takes no cognisance.

Not only are we cut off from a vast range of knowledge by the limitations of our senses, but the very fact of being dependent for all knowledge on sense-messages reduces us at once to hearsay evidence, as distinct from personal knowledge. The things-in-themselves which the sense-impressions symbolise, the realities at the other end of the nerves, remain unknown and unknowable; not a step can we go beyond the records of our "telephone exchange."

There are, of course, doubtful conveyances of knowledge through unconscious impression, intuitive perception, and possible telepathic communication, that we may touch on later—so that, while all that we have said stands, absolutely to deny the possibility of modes of perception other than those to which our senses are accustomed is unwarrantable.

Man has been left entirely to himself as regards the acquisition of physical knowledge which he makes through his senses aided by his reason. Reason unaided by the senses is helpless, and the senses unaided by reason are fallacious. To sight without reason the universe appears to be filled with light; but reason shows us that what we understand by the sensation of light does not exist outside our mind, any more than does what is conveyed by the sense of colour. To the sense of hearing, unaided by reason, the air of a busy town seems filled with sounds; but reason tells us that no sound exists outside our own mind. The sense of heat is also entirely fallacious. A metallic paperweight is cold to the touch, while the woollen tablecloth is warm; test them with a thermometer, and the temperature is the same. It is all a question of the rate at which the finger which touches them gains or loses heat. Moreover, intense cold produces sores almost indistinguishable from burns, and the sensation is very similar.

It has been established, however, that heat, though not material, has an objective existence in as complete a sense as has matter. It is interesting to note that our own range of heat consists of but 10°, below and above which we cannot exist; and it therefore follows that within this range alone, knowledge of all sorts is possible.

Thought also has its narrow limits; neither beginnings nor endings are conceivable. The structure of our brain even forbids concepts of the spirit, which is bigger than the finite brain, its instrument.

Owing to our senses being limited by thoughts of time and space, we are surrounded by inconceivables. Infinite space is inconceivable to us, and so is limited space; and yet one of the two must exist. Matter must be infinitely divisible, or not so; but we can conceive of neither. The illusion of objective colour, light, and sound is most difficult to overcome. Prof. Poincaré, in "Science and Hypotheses," points out with regard to time and space: "There is no absolute space, and we can only conceive of relative motion through it. There is no absolute time; when we say two periods are equal, the statement has no meaning, and can only acquire a meaning by a convention. Not only have we no direct intuition of the equalities of two periods of time, but we have not even direct intuition of the simultaneity of two events occurring in two different places."

The only part of the vast ocean of realities which a human being can adequately examine is that excessively small tract which consists of the impressions in his own mind, all of it but as one cupful of the great deep; and although that cupful is an actual specimen of the kind of things that exist, we are not justified in assuming that it is necessarily a fair average specimen of the whole.

"Working under these disadvantages," says Dr. Johnstone Stoney, "man has constructed a physical hypothesis whereby to enable him to form a correct forecast of the changes which will occur in nature. There has been a good deal of superficial and dogmatic utterance concerning ultimate relations; we need only cite the declaration, so common amongst scientists, that action at a distance is impossible and unthinkable, or that consciousness and mental action generally consist of motions of particles—which is much like saying that a wind consists of weathercocks."

We cannot comprehend the true nature and depth of things, for the world which we do comprehend is not the true reality but only its appearance. Science is really most great and wonderful when she discovers her limitations and sees behind the barriers the mystery of the infinite.

Another possible limitation is that we cannot think of nature save as a unified system of inter-related parts, nor can we escape from the idea that every event must have a cause. Huxley reminds us that the association of extension and resistance is an insoluble mystery. Sir William Hamilton points out that nothing exists for us except so far as it is known to us, and that nothing is known to us except certain modes of existence that are analogous to our faculties.

Intuition is another curious faculty, and as inscrutable as conscience. Certain things are self-evident and cannot be disproved, though incapable of proof—such, for instance, as the axiom that things that are equal to the same are equal to one another, and the fact that every effect must have a cause. All scientific knowledge rests ultimately on unprovable axioms; as Herder says: "We know that 2 × 2 = 4, but no one can tell us why."

In face of all these limitations, scientists are extremely cautious, and advance more warily each day. Indeed, nature is so inscrutable that, even when a law is discerned, the scientific explorer will not venture to say he has so read its character that the law reflects the ultimate meaning of the several phenomena it explains.

Thus far we have spoken only of science in relation to reason; but what about the emotions and feelings—the heart rather than the head?

Pascal confidently asserts that we know truth not by reason but by the heart; it is by this that we grasp first principles, such as space, time, and motion; and it is upon this knowledge that reason must fundamentally base itself.

Close observers of scientific investigators are clear that a strong bias is given to observation and thought by wish, interest, and desire; nothing is harder, for even the most judicial mind, than to go against its bias.

The Limitations of Science

The common notion that men get their opinions through the understanding only, and hold them because they are based on reason, is far from the truth. The understanding is one avenue of opinion, but a more open avenue is through the feelings. To contemplate a subject in the pure white light of knowledge without any mixture of feeling is almost impossible.

The condition of mind ideally best for the search of truth would be one so free from every disturbing passion as to love truth for truth's sake; but that is a state of perfection beyond our present powers.

No finite experience can justify anyone in saying that there is any probability that the future could coincide with the past in all time to come. In this direction Prof. De Morgan points out that humility best becomes us.

What the coming years will disclose in scientific truth no man can say. The way in which discoveries were made in the past may throw light on the means by which further advancement becomes possible. The trouble is that with advance comes complexity, until the field becomes so large that each scientist becomes perforce a specialist, and what he gains in depth he must lose in breadth. Haeckel says: "We have to admit with regret that most of the representatives of what are called the exact sciences are content with a special care of their own narrow branches of observation and experiment, and deem superfluous the deeper study of the universal connection of the phenomena they observe."

With a few general remarks we may now close this subject.

We probably know much less than we think we do, because we so often mistake assumption for knowledge. For instance, we only know consciousness in our individual selves, but we assume it in others.

All philosophies are far more likely to be right in what they affirm than in what they deny, for while apprehension of one side of truth is easy, comprehension of the whole range of truth is impossible.

" The idea that there are problems within the sphere of a man's scientific thought which can never be solved," says Karl Pearson, " is one which I have never met with, and I believe is not true. At the same time, we must one and all confess that within the sphere of thinkable things our knowledge is still the veriest shred ; we may even go so far as to assert that unto complete knowledge we shall never attain in finite time ; but this admission differs widely from the assertion that it must be unattainable."

All this is only true on account of the arbitrary way in which scientists limit the range of science. To-day it is strictly enforced that the moment science seeks to interpret natural phenomena by any other light than her own she has ceased to be science and become speculation.

The view we have taken in this chapter of our limitations, though undoubtedly true, is not altogether discouraging. It is no paradox to say that our ignorance may be scientific. We gain immensely in scientific knowledge when we discover what questions are unanswerable ; when we come to know definitely and exactly what we do not know we make a great advance in true knowledge ; and though reminded so strongly of our finite capacity, we see that it still remains for us to use to the utmost what power we have, rather than to spend our time in regretting that we have not more.

For those who accept the voice of revelation there is a time coming when knowledge will be perfected ; for our capacity will be so enlarged that we " shall know even as we are known," and that, possibly, not through any sense medium, but directly and intuitively.

CHAPTER VI

On Pseudo-Science

HUXLEY was one of the first to speak of pseudo-science as such, by which term he characterises much of the science of his day, and he warns others against mistaking it for true science.

There is still much that may, for various reasons, be considered pseudo-science. We all remember how Timothy was warned by St. Paul against the "oppositions of science falsely so called" current in his day, by which term he describes in more eloquent words than Huxley's the pseudo-science of the time.

There can be no real opposition between true science and any other form of truth, though one may be complementary to the other rather than identical with it. But much damage has been wrought, as we shall see, by these "oppositions of science falsely so called," and St. Paul's warning is still needed.

Now, in pseudo-science pure and unmixed fraud is very rare; there is generally a combination of hallucination with superstition; even in the gross frauds so common with every form of psychic phenomena there is often an admixture of these two.

In considering the various forms of pseudo-science we may say at once that a large mass of it is connected with advanced territories of knowledge which are as yet only partially explored, and where facts are not yet verified nor classified. These really belong to the borderland, and are not yet within the true scope of science; but if claimed to be so, constitute a pseudo-science.

Indeed, we may say broadly that any borderland that claims to be science is pseudo-science. When scientific men put forward as science that which is not, because it rests on untrue premises or is incapable of proof, it is pseudo-science. Fallacious conclusions are very generally the basis of pseudo-science. Erroneous reasonings are very frequent, while mistaken observations and still more false deductions are very common. Men often feed their minds, though never their bodies, on fiction.

The distinction between the theories and the facts of science is often most imperfectly made, and is the cause of a great deal of false science. We have quoted Huxley as first using the word pseudo-science; as a matter of fact, he really coined the term in an essay on science and pseudo-science, where he pointed out that theologians especially were given to citing as science that which was only pseudo-science, a charge which is quite true, it being obvious that theologians as a body are not the best fitted to distinguish between the two. Nothing can be more annoying to scientists than when outsiders who know little or nothing of the subject quote as science that which is falsely so called. Many, in trying to discredit science, have pointed to the follies of pseudo-science, thereby, however, discrediting not science but themselves.

Theologians, however, enjoy no monopoly of this, for pseudo-science, like most weeds, has an unhealthy vitality of its own, and flourishes firmly in the most unsuspected quarters, being indeed even found in the writings of Huxley himself.

I will give in an abbreviated form instances of this referred to by Hugh Capron in his " Conflict of Truth." Huxley, he says, criticises the words, "The earth was waste (without form) and void"; "waste," he considered, was too vague a term to be worthy of consideration, and "without form" was absurd, adding that "science knows nothing of any such stage in which the universe could be said, in other than a metaphorical and popular sense, to be formless."

This was in 1886. But in 1869 Huxley had quoted Kant with entire scientific approval as follows: "Kant pictures to himself the universe as once an infinite expansion of *formless* and diffused matter. . . . In vivid language he depicts the great world-maelstrom, widening the margins of its prodigious eddy in the slow progress of millions of ages, gradually reclaiming more and more of the molecular *waste*, and converting *chaos* into cosmos." Here, then, as Capron remarks, Huxley endorsed as scientific the two words "formless" and "waste," which he subsequently scorned. One may add that his scorn is not supported by any argument, but by an assertion that has no support, not even his own. This is pseudo-science.

Haeckel, according to Sir Oliver Lodge, is a conspicuous instance of a scientist turning philosopher, and teaching both pseudo-philosophy and pseudo-science. His "Riddle of the Universe" is full of pseudo-science, in other words, of guesswork. He states (as ascertained facts) that the universe is eternal, infinite, and illimitable; that its substance has two attributes, matter and energy; that it fills all space, and is in eternal motion, and so on: all of which may or may not be true, but has certainly never been proved.

The law of the conservation of energy itself is only true if heat be included as a form of energy, while the law of the conservation of matter is not really proved.

The electrical basis of matter is as yet but a theory, and not proved by experimental test.

Persistence of the existent is also not yet proved; and from the point of view of strict science it is not possible to give any positive answer to any of these questions, although Haeckel asserted not only that the scientific answer can be given, but that it has been given, and that he knows what it is.

Apperception, or the linking of one thought to another, is an invaluable aid in scientific investigation, but both analogy and imagination are full of perils. False analogies only perceive the resemblances, and fail to recognise the essential differences, between the things compared, and this is one of the most subtle snares set for the human mind; and thus again is pseudo-science fostered.

Much pseudo-science is concerned with inherent impossibilities; for inventive science has accomplished so much that the ordinary mind cannot see the difference between unknown possibilities and scientific impossibilities.

True science must, as we have seen, advance by hypotheses; the evil is that some of the scientific postulates have passed as axioms, and hypotheses have been regarded as facts and laws. This again is pseudo-science.

The six follies of science were formerly considered to be:

Squaring the circle.
Duplicating the cube.
Trisecting the angle.
Perpetual motion.
The transmutation of metals.
The elixir of life.

But while one or more of these have now ceased to be follies, others so numerous have taken their place that enumeration is impossible.

CHAPTER VII

The Message of Modern Science

A CONSIDERATION, however brief, of the present position of scientific truth deeply impresses the thoughtful observer with the marvel of the scientist, and of his science.

A scientist is a special type of man. Wherever found, of whatever nation, country, or creed he may be, the resemblances of scientists to each other are much more striking than their differences.

We are, of course, impressed first of all by the obvious; and what immediately arrests us in a great scientist is not his knowledge, but himself—his patience, humility, self-denial, loyalty, honour, self-sacrifice, courage, zeal, truth, judgment, and sanity. Whether he lives in obscurity and penury, or is great and famous, these qualities remain the same: he is a noble and lofty type of man.

A deeper observation reveals that he is also, as a rule, a happy, contented man: not to be pitied, but rather to be envied. He is delivered from the unsatisfactory aims of worldly men, and is happy in the steady pursuit of his interesting work.

Then, as to his science, what wonders lie here! If it be on the level of the applied and practical, it is a part of that which has brought beauty and comfort into human life, and made our civilisation possible and progressive. It has been the means of saving time and labour everywhere, and simultaneously increasing speed and safety.

Its record extends also, as we know, to the horrors of war; and at no time since the world began has applied science been devoted to such destructive ends as in this great war.

If the science be of a more theoretical nature—the study of phenomena, and the framing of laws—we get principles, order, classification, proportion, simplicity, and unity in diversity brought out everywhere.

But what shall we say of the highest class of science, which is devoted to unravelling the deepest problems of nature—molecular structure, the nature of light, gravitation, space, force, etc.? Instead of here discovering, as scientists have every right to expect, a solid and quiescent ultimate basis of matter, they are suddenly confronted by a whirling universe of perpetual microscopic motion, and, as we shall see, our old, solid, respectable atom itself vanishes in a trio of "E's"—Energy, Ether, and Electricity.

Before the revelations of the ultra-microscope the observer becomes dumb with awe and wonder; and as he progresses along his novel and amazing path he often passes from wonder to worship, from worship to faith, from faith to light, and from light to God! It will presently appear that two scientific facts emerge clearly from the most recent knowledge. One, that the immaterial and invisible have wholly replaced the material and the visible; the other, that all science is tending to one great central Unity.

PART II

THE TWILIGHT OR BORDERLANDS OF SCIENCE

The 'wilder'd mind is toss'd and lost,
O sea, in thine eternal tide;
The reeling brain essays in vain,
O stars, to grasp the vastness wide.
The terrible, tremendous scheme
That glimmers in each glancing light,
O night, O stars, too rudely jars
The finite with the infinite.

ANON.

CHAPTER VIII

The Borderlands Generally

THE word "borderland" in general conversation is limited to its connection with psychic manifestations and psychological problems in general. A very superficial examination, however, reveals that each of the almost innumerable sciences into which the study of the universe is now divided has its own borderland, its own region of mystery, of the imperfectly known, of shadowy outlines.

We use the word "borderland" in a very general sense, and by it we would include all that lies in twilight, all that part of the disc that is illumined clearly neither by the circumferential lights of science nor by the central light of revelation. This includes the non-proven, the possible, the non-provable, the uncertain, the doubtful, the half-known, the probable, the improbable, and the seemingly impossible.

Borderland is described by the Society for Psychical Research as a condition between sleeping and waking, or a sort of dreamland; but the essential difference between the borderland of which we speak, and dreamland, is that the former does contain certain realities, only they are not fully known or understood, whereas the latter does not.

The borderland generally is the territory between the known and the unknown. With regard to the latter, most of it, as we have seen, though impenetrable to science, is clearly lighted by revelation; but we must admit here that there are some few districts of thought which are illumined neither by science nor by religion, nor are they even in the borderland or twilight, but remain utterly unknown, in thick darkness. Such are the ultimate cause of the origin of evil, and the coexistence of omnipotence and freewill. Fortunately these very obscure territories are mostly ultra-scientific, and belong chiefly to the region of metaphysics.

As we pass on we shall find two things in regard to science and the various borderlands. First, that much of what passes as scientific truth is not such, but is still in the twilight of hypothesis and theory, and that the range of really true science is therefore much more limited than we thought. In the second place, we shall notice that there are some cases where, so far from science having advanced, it has had to retreat; and what was once believed to be a scientific truth is now found either to be utterly false, or to be in the doubtful region of the borderland. All this makes one most cautious in advancing any claims on the grounds of scientific truth.

Most origins and causes are clearly not borderlands, either to science or revelation, being wholly unknown to the former, and fully revealed by the latter; so that if viewed from the circumference of our great disc they are in thick darkness, while from the central unity they are in bright light.

In physics, one may instance the passing of optic and aural vibrations into sight and sound as illustrations of borderland phenomena; in mathematics, the real meaning of number; in botany, the manner in which sunlight affects plants; in general science, the existence of ether, of matter, even of time and space—all of which are borderland questions. Often the simple question of a child lays bare one of these problems, and is quite unanswerable.

As we advance in the study of this section we shall find out the boundaries of each science, and what really constitutes its particular borderland.

One great point is that although conscious of such mysteries, we should not ourselves become mystics. In borderland questions there is generally a tendency to exaggerate any mystery that surrounds them. Their study and that of the so-called "mysteries," such as the greater and lesser mysteries of the East, contains in reality but little mystery, and is often merely the elucidation of unsolved problems.

There is no doubt, however, that as we leave the clear though limited light of science we become conscious of a vague premonition or prescience of the spirit world, and this is especially the case in all psychical problems. This is not only because the light of reason here fails to be sufficient to illumine our path, and because obscurity tends to encourage fancies, but because as we dive deeper and get nearer the heart, the centre, the origin of things, we begin to feel the presence of the One who is the Author and Centre of them all. While not denying this as a fact, it is well in all such investigations to keep our minds as clear and as simple as we can. There is, however, a sense in which we may be said to be more at home in the borderland of doubt and surmise with which we are so familiar, than in the bright light of ascertained truth, which is comparatively strange to us.

But there is more, far more than this in the borderland question. I have already hinted that our ignorance is increasing faster than our knowledge, for it is only by knowledge that we reach conscious ignorance. We have advanced very rapidly in research, and discovered more and more the extent of our ignorance, and not only so but the extent of our mental limitations, which press on us with cruel force. In the universe of life we practically know nothing with absolute certainty; almost all is borderland. In the inorganic universe, as I have said, all the solid world has now dissolved before our eyes and remains as a doubtful borderland of force alone.

Is science, therefore, to be confined to the study and practical application for human use of various superficial phenomena? It almost seems like it. We may, of course, be on the very verge of the discovery of immense truths; but, as I write, twilight prevails everywhere, and the general survey of borderland at the present moment proclaims that it was never before so extensive and so universal. Undoubtedly this is a kind of tribute to knowledge and research, but it is not the tribute that we expected.

CHAPTER IX

Borderland in Psychology

As psychology is the science usually most associated with borderland, it may be well to study its scope first, especially as we shall be able to investigate its borderland far more completely than that of any other science, it being the special science at which I have long worked. There is, however, a difficulty in writing about psychology, arising from the fact that the science of the mind itself, and therefore the meaning of its various phenomena, is only now emerging from the borderland where it has so long lain, and is beginning to be slowly, very slowly understood.

Here I must be dogmatic, and as the author of a work on the unconscious mind, written nearly twenty years ago,* briefly give what, I believe, is the true concept of mind. This concept, when I presented it to scientists at the close of the nineteenth century, was received with scorn and ridicule, so complete was the twilight in which the mind was then seen. But now, with slight modifications, the concept, which I shall here shortly summarise, is generally accepted, although there are some stout-hearted scientific relics of an earlier age who still stand out against it.

First as to " psychology " itself : the word is a comparatively new one. In the seventeenth century it was a part of metaphysics, and no other word is used by Descartes, Malebranche, and Leibnitz. The word psychology was invented by an obscure writer called Goelemus, and its definition, given by Prof. Ladd and quoted by Prof. James, is, " the description and explanation of states of consciousness as such."* The latter proceeds: " When, then, we talk of psychology as a natural science, we must not assume that that means a sort of psychology that stands at last on solid ground"! Prof. Edward Montgomery goes even farther, condemning *in toto* the above narrow limitation of the science: " Psychology, as a science of self-originated and self-acting conscious existence, rests (at present) on eminently fictitious assumptions, and can only lead to nihilistic results; such a science constructed without reference to an abiding *extra-conscious* source of actuation and emanation will end in vacancy." †

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* " The Unconscious Mind," by A. T. Schofield, M.D. 2nd edition. This book should be read by those who would get a full grasp of the distinction between the sub-conscious and the unconscious.

Psychology has been, indeed, until lately, so fettered and bound by its arbitrary definition as alone " discussing states of consciousness " that it is described (or decried) by Prof. James thus: " Psychology is but a string of raw facts, a little gossip and wrangle about opinions, a little classification and generalisation on the mere descriptive level, a strong prejudice that we have states of mind, and that our brain conditions them, but not a single law in the sense that physics shows us laws."‡ After all, what we have here is a house not merely divided against itself, but in a state of chaos, a science bristling with contradictions, its greatest agreement being in the general but erroneous proposition that consciousness and mind are one and the same, the sphere of the latter being so entirely defined by the extent of the former that to speak of unconscious mental phenomena is said to destroy the meaning of words, to betray confusion of thought, and, in fact, to talk nonsense.

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* W. James, "Psychology," p. 1.

† Ed. Montgomery, *Mind*, vol. xiv., p. 499. Still he refuses to call these extra-conscious states "mind."

‡ W. James, *loc. cit.*, p. 468.

It is this proposition that I seek to overthrow, for it is my firm belief that it is mainly from want of a broader basis, and from a rigid adherence to this narrow and mistaken shibboleth, that psychology has not made a greater advance and reared a more imposing structure.

Our conscious mind, as compared with the unconscious mind, has been likened to the visible spectrum of the sun's rays as compared with the invisible part which stretches indefinitely at either end. We know now that the chief part of heat comes from the infra-red rays which show no light, and that most of the chemical changes in the vegetable world are the results of the ultra-violet rays at the other end of the spectrum, which are equally invisible to the eye, and are only recognised by their potent effects. Indeed, just as these invisible rays extend indefinitely on both sides of the visible spectrum, so we may say that the mind includes not only the visible or conscious part of the mind and what we may term the infra-conscious, that lies immediately below or at the red end, but also a supra-conscious mind that lies beyond at the other end—all those regions of higher soul and spirit life of which we are only at times vaguely conscious, but which always exist, linking us on to eternal verities on the one side, as surely as the infra-conscious mind links us to the body and its animal life on the other.

The mind indeed reaches all the way, and while, on the one hand, it is inspired by the Almighty, on the other it energises the body, all of whose purposive life it originates. We may call the supra-conscious mind the sphere of the spirit life, and the infra-conscious mind the sphere of the body life, and the conscious mind the middle region, where both meet, the sphere of intellectual life; for it appears indeed to me that the range of the conscious mind alone is but a very small part of the whole scope of the psychic force in man.

A coral island in the South Pacific may be of insignificant size to the sailor, but the biologist or geologist knows that it is the visible part of a great mountain which rises from the bottom of the ocean. Most are only conscious of the visible part; of the submerged part they are unconscious, because it is invisible. In the same way it appears to me that of the whole of the psychic forces which are mental and which constitute mind, only a very small part is illumined by what we call consciousness.

There are really three regions—the conscious, fully illuminated; the sub-conscious, whose operations are only seen with difficulty at times by introspection; and the unconscious, where all the operations are entirely beyond the range of observation. The sub-conscious may be well compared to the stretch of shore on the island between high and low tides, that is sometimes invisible and sometimes visible.

We will now sum up the evidence for the existence of mind below consciousness in the words of Bastian: "If we are, as so many philosophers tell us, to regard the sphere of mind as co-extensive with the sphere of consciousness, we shall find mind reduced to a mere imperfect, disjointed series of agglomerations of feelings and conscious states of various kinds, while a multitude of initial or intermediate nerve actions would have no claim to be included in this category. For these and other reasons we feel ourselves driven to the conclusion that the common notion as to what should be included under the term 'mind' is one which is altogether erroneous. If we are compelled to believe that consciousness is not co-extensive with the sphere of mind in face of the now admitted fact concerning the frequent interpolation of unconscious nerve actions as integral parts of mental processes, only one course lies open to us—we must widen the signification of the term 'mind' itself. This is no question of choice, but one of absolute necessity. The meaning of the word 'mind' must be considerably enlarged so as to include as mental phenomena the functional results of all nerve actions, whether these nerve actions are accompanied by a recognised conscious phasis or no. Let us, then, enlarge our conception and definition of 'mind'; let us openly profess that which is already tacitly implied by 'mind.' Instead of supposing that mind and consciousness are co-extensive, let us make mind include all forms of nerve action. We must inevitably come to this, and the doctrine of 'unconscious cerebration' has served to pave the way for it." *

And yet "to talk of unconscious mental states," says Prof. Ladd, "is to talk of the inconceivable, of wooden iron, of the 'unconscious conscious,' as it were." †

Prof. Edward Montgomery writes: "Everyone feels that to speak of unconscious mental states is not only to be uttering a paradox, but to be almost as preposterous as if he were to assert non-existent existence."

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* C. Bastian, "Brain as an Organ of Mind," p. 146.

† G. T. Ladd, "Philosophy of Mind," p. 395.

It has perplexed many that such an attitude should ever have been taken, and still more that it has been persisted in so long, though there is doubtless a great attraction in limiting states of mind to the illuminated disc of consciousness. Little clear laws can be laid down and neat definitions made within this fixed horizon, and there is, moreover, a deceptive appearance of accuracy in recording the results of a skilled interrogation of one's own consciousness, and in refusing all testimonies as to mind that are not arrived at and cannot be tested by this one process.

"Psychology," says Prof. Bucke, formerly President of the Psychological Section of the British Medical Association, "should be the most interesting of all the sciences, and, as a matter of fact, it undoubtedly is so, though it has been greatly discredited by the imperfection of the method by which it has until very lately been studied. That imperfection is so great that it would hardly be an exaggeration to assert that nearly all the study and thought expended on it down to the beginning of our own age has been fruitless and as good as wasted, excepting inasmuch as it has at last made clear the impassability of the route men have sought to follow, the route, namely, of introspection." * There can be no doubt whatever that the widening of the basis of psychology so as to include all mental operations, whether within or without the sphere of consciousness, has placed the whole science upon a different basis, and, as we shall see, the recognition of the unconscious mind as a scientific fact has solved many of the otherwise inexplicable problems in psychology and medicine. Up to now, even in our respectable textbooks, almost everything that we did not do ourselves was the work of Nature, a

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* Dr. R. M. Bucke, *British Medical Journal*, Sept. 11, 1897.

powerful female goddess created by medical psychologists as the only solution of their problems. We rejoice to know that this fictitious lady is now largely supplanted by the more scientific concept of the "unconscious mind."

Frederic Myers points out as a corollary to this recent enlargement of "mind" that the "ego" now includes supraliminal, ordinary, and subliminal consciousness; or, in the language I prefer, the ego uses both mind and body, being itself spirit; the mind being now divisible into conscious, sub-conscious, and unconscious districts, which can be distinguished not only psychologically but physiologically.

Another important matter as a preliminary to the study of psychical phenomena is to distinguish between the intellect and the emotions, and to remember that while the brain is the seat of the former, the solar plexus and its ganglia are largely the home of the latter. There is no doubt that the brain is in some way the organ of thought.

Thought is dependent upon cerebral activity, and yet it is impossible to find the real connection, and it may be doubted whether the relation is causal at all. How movements of atoms can produce sensation and conscious thought is wholly at present a borderland question, for we can form no concept whatever either of the relations of brain and mind, or of the production of consciousness.

Some, hoping to make matters easier, regard man not as a unity, but as a simple co-ordination of body, soul, and spirit. The distinction, however, is not important; it is far more to the purpose to note the relative positions of instinct (so glorified by Bergson) and reason. Instinct rules and reason serves, and all great actions in our lives are governed rather by instinct than by reason. The great faculty of instinct is connected with the unconscious mind, and also physically with the solar plexus; its ultimate origin is a borderland question. To some scientists it is an evidence of lapsed reason, which to others seems hardly possible. The chief argument in favour of this theory seems to me to be the fact that in the formation of habits which once were produced by reason and thought, we find these replaced almost entirely by unconscious instinct, and we call them artificial reflexes. This is an analogy in us to the instinct of animals. We have, of course, three modes of action—pure involuntary instinct, beyond all control of will, or natural reflexes, such as blushing; acquired habits, partly instinctive and partly reasonable and voluntary, or artificial reflexes; and lastly, reasonable acts wholly governed by will power.

Of course, even in stating this, we are simply raising other questions: What is reason? What is will power? In fact, who is this "ego" and what also is the real difference between soul and spirit, or between my mind and myself? How do I know that I am I, and that my mind and body are merely agents that I can use at will? To all of these questions only partial answers can be given; they are, therefore, not wholly unknown, nor wholly known, and hence lie within the borderland of psychology.

Again, we have the mysterious and yet most autocratic sense of conscience with its verdict of right or wrong on every single thing we do, approving or disapproving our actions in a most arbitrary manner, from which there is no appeal; and yet this sense does not appear to be always a safe guide, for many besides St. Paul and the Inquisitors have done the most wicked things with good consciences. This sense appears to be like a sundial, that only tells the right time in solar light, but will tell any time you please with a candle. In like manner the conscience will respond to any influence it is under, but its voice can only be trusted when it is illumined by the true Light. This question of conscience is also in the borderland.

The sense of " duty," which is akin to conscience, is in the same category. Of this Kant says : " Thou sublime and mighty name, that hast in thee nothing to attract or win, but merely holdest forth a law in the presence of which all inclinations grow dim even while they secretly rebel, where can we find the root of thy noble descent, which proudly rejects all kinship with the inclinations ? "

The importance of dwelling so much upon the mind is more clearly understood when we remember that all objectives and subjectives in the universe are only known to us through this medium, which is the originator of all our concepts ; for everything is neither more nor less to each one of us than what he thinks it to be ; as Prof. Maudsley points out, " It is in fact a think, not a thing," adding that to think a new thing a man must first use the old thought. " How can he do otherwise before a new experience enables him to organise a new think ? "

Another great point to remember is the unity of man with nature ; his moral nature rules the physical, and yet the physical is the basis of the moral ; he is both the servant and the interpreter of nature ; all his independence, and the highest exercise of his loftiest powers, receive a salutary warning against pride when he discovers to his dismay that their very exercise is conditioned by the presence or absence of food. It is clear that profound psychological changes can be produced by physical causes, and it is equally true and beyond doubt that physical changes are readily induced through psychical influences, though this latter fact is not so generally known.

To return to our subject. The discovery of the unconscious mind has to many solved most of the problems of psychic phenomena that we shall discuss; but, as is usual in the discovery of fresh power or remedy, we often ascribe too much to it. It is not true that all that is seen or heard in these phenomena is subjective, and is the product of an unrecognised part of our own mind. Maeterlinck, who, in his "Unknown Guest," has made a most interesting study of the whole subject, says, indeed, that if you do away with the unconscious mind you are obliged to people the world and burden your life with hypothetical and imaginary spiritual beings: accept it, and all these become superfluous or accessary. This is, however, only partly true.

Again, the unconscious mind means different things to different people. To me there is but one human mind, and the unconscious mind is merely that part of it that cannot be seen by the eye of consciousness.

Hudson's proposition that man has two minds, the one objective and the other subjective, the latter being incapable of inductive reasoning but easily controlled by suggestion, contains the germs of a great truth. It is more probable and more in accordance with evidence, however, that the mind is but one, and that Hudson's "objective mind" consists of those regions which are within the sphere of consciousness, while by his "subjective mind" he means the unconscious regions of the brain.

Sir Oliver Lodge sees in the unconscious mind a part of our being that has not become developed. Gustave Le Bon thinks it is the condensed soul of our ancestors;

William James, that it is a diffuse cosmic consciousness containing the vestiges of the primordial chaos; Myers, that it is cosmic, and Divine in its direct origin.

Maeterlinck is immensely puzzled, and naturally so, at the contrast between a reasonable mind and its supposed unconscious products in so many psychic manifestations. He asks: " But how can we explain the incredible contrast between the grandeur and calmness of this inner life, and the puerile and grotesque incongruities which it manifests at times? Inside us the unconscious mind is the sovereign judge, the supreme arbiter and the prophet. In external actions it becomes somewhat of a mountebank or clown. This unknown guest has no fixed doctrine. In one part of the world it declares spirits undergo reincarnation, and tells the story of their past existence; in England, on the contrary, it generally asserts that they do not become reincarnate. It deludes itself or deludes us. Why does it do so? It asks for nothing, neither for money, nor prayers, nor thoughts. What is the use of these puerile pranks? It must be for the pleasure of lying; and yet I cannot believe the truth is as hideous as this. Our unknown guest does not deceive itself any more than it deceives us, but it is we who deceive ourselves." *

We may see farther into this obscure subject in a subsequent chapter; at present we can only say we do not believe that these freakish phenomena at séances which are not impostures are wholly subjective.

A remarkable exercise of the unrivalled powers of the unconscious mind, and of animal instinct, is seen in the wonderful feats of the famous Elberfeld horses, whose powers in giving at once cube roots or cubes of large numbers, as well as in answering questions intelligently,

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* Maurice Maeterlinck, " The Unknown Guest."

are almost beyond our capacity to believe, and yet are so clearly certified by men of science that they are not to be doubted. All interested in this subject should read Maeterlinck's account of these horses in " The Unknown Guest."

Another borderland question in psychology is that of monism or dualism—in fact, whether the existence of spirit at all is a scientific fact, or a borderland question. One would have thought this matter at any rate was beyond dispute, but it certainly is not so to followers of Haeckel and others who still exist among us.

Other phenomena in the doubtful territory are certain nerve forces, aura, hypnotism, faith-healing, possession, telepathy, automatic writing, appearances after death, materialisation of spirits, clairvoyance and double personality, all of which we shall briefly discuss in subsequent chapters.

Inasmuch as the only psychology which we actually know (and that most imperfectly) is that of ourselves, we must generalise from the individual and the particular to the race and the general, and postulate as true of others what we know to be true of ourselves. Such an assumption, though essential to all psychological argument, is incapable of abstract proof, for the only facts that we really know as beyond all doubt are those within our own individual consciousness.

One of the commonest and greatest assumptions of everyday life—that other beings have consciousness as well as ourselves—is as little proved scientifically as the statement that an apple would fall to the ground if taken to a planet of another system ; both assume a uniformity of force which cannot be proved.

It must be conceded, therefore, that few things in psychology admit of scientific demonstration ; but though most of them may still be in the borderland, they have a supreme attraction for our minds, and, in spite of the forbidding charlatanism that seems endemic to psychic phenomena, they have all a great scientific interest. The reason doubtless is that they seem to promise light on interesting problems which appear to be insoluble apart from revelation, such as those concerning the future life and the existence of disembodied and other spirits. Myers considers, indeed, that in virtue of borderland discoveries it is probable that a century hence all reasonable men will believe in the resurrection of Christ, even apart from scriptural authority, whereas in default of the new evidence he believes that no reasonable man a century hence would credit it. I do not know how many of us share this forecast. It is certainly not mine.

CHAPTER X

Suggestion and Telepathy

HERE we plunge at last *in medias res,* into a definite tract of the borderland of psychology, having first of all tried to clear the ground by giving some concept of the modern presentment of mind.

We have not disguised the fact that the unconscious mind is still hotly denied by some survivals, but most of the newer authorities in science agree with it in principle; some, indeed, still shy at the word "unconscious," or even its inaccurate synonym "sub-conscious," and prefer to speak of a secondary or perhaps a "subliminal" consciousness, thus making a double consciousness. But surely in this case Dr. Hyslop's formidable explanation of double consciousness, with its polysyllabic horrors, is quite enough to make us reject it. He takes this secondary consciousness to be "a supposed inhibition of the amœboid movements in the pseudopodic protoplasmic prolongation of the neurospongium."

In any case, in relation to ordinary consciousness, secondary consciousness practically equals unconsciousness.

We will first consider hypnotism and suggestion, the first being now but a special form of the latter. I give one or two illustrations derived from sources of unquestioned accuracy.

A young lady of 19 was placed under hypnotic treatment by a physician well known to me, for violent muscular tremors of all the limbs, with headache, cardiac pain, and other symptoms. After the failure of ordinary medicine, the patient was hypnotised eleven times in all, cured, and returned to her work. Opportunity was, however, taken, before she left, to test her mental powers in the hypnotic state, and on Wednesday, March 11th, at 4 p.m., she was hypnotised in the presence of four medical men, and four suggestions were made, that she should make a cross on a piece of paper after the expiration of certain specified numbers of minutes. These numbers were 21,400, 21,420, 21,428, 21,434. On the right day, Thursday, March 26th, the lady was hypnotised, and in that condition voluntarily asked for pencil and paper, and made the four crosses spontaneously without suggestion; two of them at the exact minute, one a minute, and the other two minutes too soon. The same physician records that he only accidentally discovered that deep hypnosis was associated with this accurate appreciation of time.

He found that the following suggestions could be given with success :—

1. A simple act suggested during hypnosis was to be carried out at a given time before that state terminated.

2. This state was to terminate at a specified future hour.

3. A simple act was to be performed at a given hour after the termination of hypnosis.

4. The subject was to wake from natural sleep at a given hour.

5. The subject was to pass into the hypnotic condition at a given hour, remain hypnotised for a specified length of time, perform certain acts at stated intervals, then return to the normal state, remain in it for a specified time, and again pass into the hypnotic condition.

These experiments were continued for three years, and frequently repeated before competent observers. The majority of the suggestions were executed at the moment indicated, while in the remainder the error in time rarely exceeded five minutes.

The following is from Braid : " A London physician who mesmerised by the use of a powerful magnet had a patient in a magnetic (hypnotic) sleep ; he told me the mere touch of a magnet on a limb would at once stiffen it, which proved to be the case. I now told him I had a small instrument in my pocket which was quite as powerful, and offered to operate on his patient, whom I had never seen before, and who was asleep when I entered the room. My instrument was only 3 in. long, as thick as a quill, with a ring at the end. I told him, when put in the patient's hands, both arms would become rigid, and such was the case. I then took the instrument from her and again returned it in another position and told him it would have the reverse effect, and she would not be able to hold it, and that if her hand were forcibly closed on it, it would open of itself, and such was the case, to the great surprise of the doctor, who wanted to know what had been done to the instrument to give it this opposite power. This I declined to tell him until he had seen further proofs of its powers. I told him a touch with it on either leg would cause that leg to rise and become rigid, and such was the case ; that a second touch would relax the rigidity and cause it to fall, which proved to be a fact. She then awoke. I then applied the ring of my instrument to the third finger of her right hand, from which I suspended it, and told the doctor it would send her to sleep. To this he replied : ' It never will ! ' I told him I was sure of it. She speedily went to sleep. Having roused her again, I put the instrument on the second finger of her left hand and told the doctor she could not go to sleep when it was placed there. He said she would, and gazed steadily at her to send her off. After some time he asked her if she did not feel sleepy, to which she replied, 'Not at all.' I then requested her to look at the point of the forefinger of her right hand, which I told the doctor would send her to sleep; and such was the case. I then roused her, and sent her to sleep by making her look at the nail of the thumb of the left hand. I then explained to the doctor that the wonderful instrument I had used was the key and ring of my portmanteau."

With regard to hypnotism, its basis of operations is nothing more nor less than the unconscious mind, and whatever marvels lie in its operations are due to the power of exciting to action this hidden psychic force while consciousness is in abeyance. For if there be one fact above all others that is essential in all true manifestations it is that consciousness must be dormant in the hypnotic state. Whether it be the production of a blister from a postage-stamp or the curing of some functional disease, both are effected by an agency which has power over body forces and sensations. Call this a secondary consciousness if you will, it is, at any rate, one of which in ordinary life we are wholly unconscious, and is undoubtedly a psychic force. It is, therefore, proved that, whatever we may call it when active in hypnotism, in ordinary life it can be nothing more nor less than the unconscious mind.

In the more modern methods of hypnotism the patient is seldom actually sent to sleep, but is reduced to a perfectly passive state in a quiet, darkened room; similar effects to those I have described are then produced by persistent audible suggestion. My theory—and I think it is generally accepted—is that, the conscious mind being in abeyance, these suggestions reach the unconscious mind, which alone can produce the results. But, of course, it must be confessed that all this is still very considerably in the borderland, for the exact manner in which suggestion works is unknown.

One complete system of psychic healing, greatly in vogue in America for diseases of character, consists of sitting in an easy-chair and auto-suggesting through the eye; it is called mental photography. A book is placed on a stand before a patient who suffers, let us say, from deceitfulness. On the open page, in very large letters, are the words, "I am truthful." The patient gazes at this from five to fifteen minutes without moving, goes to bed, and wakes up in the morning a reformed character! By these means it is said to be possible to cure all one's defects in turn, though the operation may, of course, have to be repeated.

With regard to auto-suggestion, Sir George Savage, the alienist, possesses, in common with many others, the faculty of waking at a given hour. One day, having to catch an early train, he determined to wake at 6 o'clock, and slept soundly without waking until the exact time; but the seven following mornings he also awoke exactly at 6, notwithstanding that he went to bed at different hours and there was no necessity for early rising. When in the Alps, if he were called at 2 A.M. one morning he would wake spontaneously at the same hour the next morning, even if he had been much fatigued with climbing. The accuracy of the time of waking in these instances greatly puzzled him, just as a similar accuracy has also puzzled me.

Hudson concludes from his observations that the best possible condition for the conveyance of therapeutic suggestion from the healer to the patient is obtained when both are in a state of natural sleep, and such suggestion can be communicated by an effort of concentrated will on the part of the healer made just before he goes to sleep.

There can be no doubt that the sole solution of the problems of hypnotism and telepathy lies in the unconscious mind. Both are but different forms of suggestion, telepathy being suggestion at a distance.

" Suggestion," says Myers, " is the process of effectively impressing upon the subliminal intelligence [unconscious mind] the wishes of some other person. Telepathy is the communication of impressions of any kind from one mind to another, independently of the recognised channels and senses."

According to Frank Podmore (of the Society for Psychical Research), telepathy is the only thing in spiritualistic phenomena that is established as a scientific fact beyond all doubt ; but this surely is a rather bold statement. Its practice is indeed a familiar drawing-room diversion ; familiar subjects being mentally projected by one person and received and described by another, the thought presumably passing between the two. The simplest experiment in telepathy is for one securely blindfolded person to form part of a circle of friends ; let these friends have before their eyes some card or book or other object on which they all fix their minds in perfect silence ; after a time, the blindfolded sitter may receive, by degrees, an impression of the object on which they are concentrating their attention.

Suggestion of all sorts is a vast and little-explored region in psychology ; it is being rapidly investigated and illumined by scientific experiments, and before long will emerge from the twilight into the clear light of truth. Its medical powers will be considered in Chapter XIX.

Collective hypnotism is suggestion to many simultaneously; it is seen in the mystic influence of great crowds at political, social, and religious gatherings and conventions, and is in itself a mystery; it is also seen in a remarkable manner in less-known ways, as I shall point out in a later chapter.

The Psychical Research Society has conducted innumerable experiments in telepathy; it believes that, in common with apparitions at death, it is the result of something entirely beyond chance, and that the two groups of phenomena are in some way allied.

The evidence for telepathy presents a complete contrast to that which has supported the belief in magical occurrences, comes for the most part from educated persons who are not predisposed to accept the reality of the phenomena, and has been most carefully sifted and tested in thousands of cases.

Travellers in Africa have constantly reported cases in which important news has travelled hundreds of miles across the country from tribe to tribe with a speed far outstripping the post; and none of them seems to have any satisfactory explanation of the means by which this is done.

Telepathy, though new to experimental science, is familiar in all the higher forms of religion. That relations inexpressible in terms of matter subsist between the human and the divine are implied in the very thought of praise, prayer, and worship.

Tennyson anticipates telepathy in the lines:

"*Star to star vibrates light; may soul to soul*
  Strike through some finer medium of her own."

We may therefore take it that, by experiment, the Society for Psychical Research has established beyond dispute that telepathy is the supersensory transference of thoughts and feelings from one mind to another, and is an established fact. The Society's testimony has proved that impressions and voices and figures of people undergoing some crisis, especially that of death, are perceived by their friends and relatives with a frequency which mere coincidence cannot explain. These phantoms appear to be instances of the supersensory action of one mind on another.

Alfred Russel Wallace says: " The scientific world has been proved to have been totally wrong in its denial of the facts of psychic phenomena; to call the subjective unconscious mind the sole author of these phenomena is as unscientific as attributing them to spirit agency."

In favour of telepathy, Sir Oliver Lodge, in " Man and the Universe," remarks: " The facts of telepathy must be regarded as practically established in the judgment of those who have studied them."

In explaining the transference of thought, the scientific attitude is naturally always to assume a physical medium for telepathy, and to discover it if possible.

Sir William Barrett thinks that telepathy and psychical phenomena do not belong to the material plane at all, and have no connection whatever with the operations of wireless telegraphy, but that " in some way " the unconscious mind of the agent transfers thought instantaneously across space to the unconscious mind of the percipient. This is a remarkable concept.

Some finer substance, at any rate, than the ether is necessary for the transmission of thought. Bars of iron can be made to vibrate at long distances by striking a sympathetic note; but then, of course, we know the medium between them. What medium, however, can we imagine that can not only carry thought between man and man across the limited surface of the globe, but can convey thought to God? In spite, therefore, of the claim that telepathy is now in the region of scientific light, we must insist that most of its problems still remain in the borderland.

CHAPTER XI

Aura and Colour Vision

In these subjects we reach most debatable studies of the greatest interest in the psychological borderland. Personally, I believe that the fact of the existence of the aura has passed from the twilight of borderland into the light of scientific fact, though many details connected with it require further proof.

I will give here, briefly, four testimonies as to facts.

The first is from the wife of a Church dignitary in the Midlands; next, my own experience, made possible by the kindness of Dr. Kilner, whose remarks will follow; and lastly, that of a well-known specialist in Harley Street, who will also tell us about colour vision.

The lady has been known to me for many years, and inherits from her mother and grandmother the gift of seeing colour mists round people; she says these mists have always been of great use to her, and distinguish persons even better than do their features. I have questioned her unexpectedly many times, and she never has the smallest hesitation in immediately telling me the colour that surrounds anyone in a room. Briefly, her classification is as follows:—

Purple = Sensual. (This does not agree with the interpretation of other observers.)
Blue = Religious.
Black = Easily led.

Brown = Deceitful and selfish.
Grey = Cold.
White = Open, simple character.
Yellow = Intellect and powerful thought.
Green = Quiet, peaceful, shallow.
Pink = Affectionate.
Red = Passionate, sympathetic, musical, constant and true.

Most of these agree with Mrs. Besant's table, and with other results I have obtained from medical men. My friend further says that people with confused thought have no distinct outline to their auras, whereas those with marked individuality and expression have sharp edges. She often notices sparks appearing in the aura as vivid ideas occur, and also in the case of anger. Very reserved people have a frosted appearance over the aura when in company ; only when alone does it become clear. When two people are close together their auras overlap, but never mingle, simply passing one behind the other. Some colours, such as blue, give a feeling of great confidence ; doctors with blue auras are always trusted by their patients !

With regard to colour vision, this lady noticed that when she played the piano the music produced beautiful colours which she could alter at will as she played. She has not been a mother very long, and has been greatly interested in her baby's aura. At first extremely faint and white, as the baby grew the aura became much brighter, and with the first feeling of affection a faint rose colour tinged it.

Colour comes with character, and is never distinct in very young children. The lady says that children almost always take some of the colour of their parents. In old people, she notices, the colour fades as the years go on, until there is a kind of bloom or veil thrown over it.

There are thousands of shades of each colour, so that one cannot really lay down any exact laws. She thinks all lecturers and public speakers should have yellow auras ; these can hold an audience well. Many people show more than one colour, changing according to the side of their character presented at the time.

The reader must understand that all the above is believed to be true by the lady who records it, but is not necessarily endorsed by the writer.

Dr. Kilner has given many years of his life to scientific research, and has gradually been drawn to the close investigation of the human aura, which, however, he does not see in colour ; indeed, so far as I can gather, he is not naturally clairvoyant at all, but he has discovered that if a liquid solution (which is blue) of a salt—dicyanin—be enclosed between two thin slips of glass, it forms a blue screen, by means of which the aura (without colour) can be seen.

Hearing of this, and being without any powers of clairvoyance myself, I asked to be allowed to make an independent study of the aura with the aid of the dicyanin screen. Dr. Kilner kindly invited me, with a medical friend, to his consulting-room, where he had a patient who would be a convenient subject for investigation.

The method is very simple, and consists first of all in gazing out of the window through the screen at a bright sky for two or three minutes ; by this time the patient must be standing, stripped, before a dark velvet curtain in the room ; the blind is then drawn down to dim the light, and you stand with your back to it, gazing steadily at the patient without the screen. As I did this, in about half a minute I began to discern the aura extending like misty seaweed from 3 to 5 inches round the body; it soon became perfectly clear and distinct, and was quite undeniable. When the patient moved, the aura moved also, and on raising her hand it streamed from the tip of each finger; but if the hand was held horizontally the aura was horizontal, showing that it was no question of rising vapour. Holding my own hands in front of myself, I could see similar manifestations, and when the fingers were about 8 inches apart their auras touched. Immediately surrounding the patient's body the aura could not be seen, but became visible about half an inch from it.

Magnets gave off in a similar way complete streams of visible force of some sort.

It appears that the reason one can see this, after gazing through the screen first, is that the effect of looking through the screen is to increase the visual power. If a man who can only read his newspaper with glasses looks first of all through such a screen in the way I have described, he can read without glasses for a considerable time, perhaps an hour or two. This would suggest that clairvoyance may be partly due to abnormal physical powers of sight.

Dr. Kilner describes the aura of a man as pretty much the same during life, whereas that of a woman undergoes a marked change at puberty. The aura may be divided into three zones—a narrow transparent zone all round the body, then a dense grey mist like a band, and lastly a thinner grey mist stretching out horizontally in health, but often drooping in weakness and disease, though never rising, as would vapour.

His further remarks are as follows: "In a man the aura is about 5 inches wide all round the body, but in a woman the aura is quite a foot wide round the head and body, contracted into 5 inches below the knees.

"The three zones of aura may be called: (1) The etheric double. This is an invisible band following the contour of the body, about ¼ inch wide, and can be seen best through colour screens; it may be striated, and coloured auras receive their tint from the colour of these lines. The aura proper lies in the second and third zones outside this. (2) More or less homogeneous and granular. (3) Always striated, has no sharp outline, and extends for varying distances.

"The aura is not vapour, for it remains stationary, whether the patient is hot or cold; it never rises in the air, as vapour would do. It is also of much finer texture than any vapour. The aura is not an integral part of the covering of the body, for it is not compressed when the body is touched. It is probably some force emanating from the body, which becomes perceptible by means of its action on the ether or atmosphere. The magnetic cloud seen round magnets has no connection with it. The power to see the aura or the magnetic haze does not arise from ordinary keenness of vision, but from an ability to see rays that are not included in the ordinary spectrum.

"The aura that streams from the tips of the fingers can be shortened or lengthened by will power directed to the part." I have seen the aura thus lengthened from 5 inches to over a foot.

The ability to see auras is probably more widely diffused than is generally known; and even the vision of coloured auras (not necessarily due to chromatic vision) is not very uncommon, and has been much studied in Russia. Auras are often seen round parts of animals as well as men.

I will now give the experience of the specialist to whom I have referred.

First, as regards auras, I may say he has seen them round patients and others, in colours, for years, without the use of any artificial aid, such as a screen. I remember that in one lecture he enumerated some twenty colours of auras, and most of his interpretations of their meaning agreed with that of Russian investigators, with those of Mrs. Besant, and of the lady of whom I have already spoken. He has also noted the three zones of the aura as described by Dr. Kilner. He adds :—

" From the earliest days of the recorded history of man and his doings there has been found some evidence that subtle rays, all unseen though they may be by most of us, have emanated from his body ; rays of so fine a grade of matter that they are not able to be cognised or sensed by our ordinary vision. In the question of aura we expressly exclude all those emanations from the body which are generally known, and which, if they cannot be seen, can be plainly demonstrated by their effects—chemical, electric, and so on—as well as the slow evaporation of water ever going on from the skin in transpiration, or those exceedingly minute molecules of scent radiating from flowers and plants [and animals], which, though unseen, are obvious to our sense of smell.

" Again, we cannot see heat rays, but we can feel them, and it is by this special sensation that we know they are present ; nor can we visualise X-rays by our ordinary sight, though these are so full of power that if thrown on to the surface of the body they will burn the skin and destroy the tissues. But what physicist would venture to deny that beyond these ordinary radiations, as known to science, there may exist whole fields of radiations which, though out of the ken of ordinary vision, can be and have been sensed by those who are gifted with a finer sight than the normal ?

" There is ample evidence that there is a whole series of colours in some finer medium than is known to us, and also that in all ages certain men and women have had the power to see these radiations, or the aura round individuals.

" We find in extremely ancient times testimony of this aura, on the walls of ruins in India, Egypt, Peru, and Yucatan ; and in the ancient caves of Ellara can be found figured, however roughly, in paintings, these emanations round the body and head of Buddha and others. In our own South Kensington Museum there are figures with the rays shown, which existed from the year B.C. 324. Since this period we have the figures of many saints and holy men drawn and sculptured with auras round them."

This physician adds that by accident he found that he was personally gifted with the finer sight mentioned, and so he determined to go into the whole matter scientifically, and thus be in a position to corroborate what he had read and heard on the subject, or, on the other hand, to refute it. With this idea he investigated the whole question quite dispassionately, and established the fact of coloured auras entirely to his own satisfaction.

It must not be supposed for a moment that I have given the only evidence obtainable in this country, but I think it is sufficient for my purpose.

I turn now to colour vision generally. Psychochromes, or colour thinkers, are not uncommon ; they attach colour quite involuntarily to all sorts of things, such as days, letters, people, events, months, etc. They are not, however, mentally abnormal, but are often intellectual and gifted people, and constitute an interesting class of whom little is known. I will proceed to give some medical evidence on this subject.

The same London physician I have quoted in reference to the aura writes as follows :—

" My wife and I had something like a thousand letters in packets from all sorts of people—from peers, paupers, geniuses, lunatics, good, bad, and indifferent characters, from patients and friends, from hovels and palaces, etc. When I had put myself into a quiescent condition, not, however, to the point of trance, my eyes were blindfolded, and a letter was picked out of a packet haphazard and placed in my hands. I was immediately brought into contact with all the conditions of the writer, past and present and future, besides seeing with the inner vision the different hues in the writer's aura. No word or hint whatever was given me as to who the writer was. When I had thus sensed different colours and conditions round the letter, my wife would take down in pencil what I dictated as to these. We continued these experiments at odd times for a long period, in fact until I had visualised some three hundred letters. The result was interesting in the extreme ; for we found, without exception, that by these means every writer stood out to me literally in his true colours, in more senses than one ; his aura was seen, his character, his home, his illnesses ; there was nothing hidden but what was revealed.

" We tabulated the cases carefully,with the result that I found all those writers round whom were certain colours had the same characteristics. For instance, all those letters which gave out a light-red or pink colour were invariably from those of an affectionate disposition, and who had a love for humanity in general. All others, on the other hand, which radiated brown were from less desirable characters, of the earth earthy; while those which radiated even darker hues and in some instances a chocolate shade were from persons of a very low moral type.

" I might say here that I only noted the most dominant colours in the aura, and that, further, these colours changed according to the condition of the writer : thus there was one writer from whom we had received several letters, written at different times of his life. In 1892 his aura was dark grey with a tinge of dark green ; he was then in bad health and under poor conditions. In a letter written in 1896 I still saw the grey, but it was lighter and there was a rim of pink round the grey ; he was then in better health and more hopeful. In 1901 the pink was dominant, though there was still a little grey ; in other words, his health and character had improved, and this showed itself clearly enough in his aura. In 1903 he was a different man altogether, mentally and physically better ; a spiritual unfoldment had occurred, and the result was seen in his aura, for this last aura exactly demonstrated his then condition—it showed a beautiful pink with points of gold, and the grey had entirely gone. Thus we had his whole history in colour.

" I may further say that it was not until I had finished this long series of experiments that I consulted other authorities on the meaning and interpretation of these colours, and was delighted to find that the conclusions I had reached exactly corresponded to those of such a well-known authority on the subject as Mr. Leadbeater, whose book on 'Man, Visible and Invisible,' I afterwards procured.

"Here is what the colours told me, without knowing in the least what particular person I was dealing with :

Dark red = Passion, want of self-control.
Light red = An ordinary individual with good points.
Pink = A lovable disposition, a humanitarian
Orange = Ambition or pride.
Light blue = General devotion, purity and goodness.
Dark blue = Philosophers and divines.
Light grey = Anxiety, nervousness.
Dark grey = Depression and illness.
Light green = Versatility.
Dark green = Jealousy.
Purple = High development. (I saw this markedly round a letter of Mr. Gladstone's, together with gold points.)
Yellow = Wisdom and intellect.
Brown = Very ordinary or low characters.
White Supposed to be the perfect colour.

I may add that I never saw white round any of the innumerable letters I tried. It is the colour depicted around saints ; there are evidently none amongst the writers of my letters."

With this interesting testimony I close the evidence, for want of space. Enough has been said to show that here we have a subject which must by no means be dismissed as the result of mere imagination, for it is established by the scientific investigation of many competent observers, and presents problems which, since they have not yet been solved by the true light of science, are certainly in the twilight of the borderland.

CHAPTER XII

Clairvoyance and Double Personality

In the last chapter we saw that by means of a chemical salt (dicyanin) the powers of sight can be physically increased, at any rate temporarily, so that to some extent the invisible becomes visible. There is no doubt whatever that to some people and to most animals this strong vision is the natural condition, but it is also clear that much more is meant by clairvoyance than merely seeing what lies beyond our ordinary sight; for beyond this again lie still more shadowy regions, and even if all the invisible were seen we should not have reached the full meaning of clairvoyance. The word is used to include the sight or vision of what presumably does not exist at the time at all, of events in the future or far past. The Scots call this gift "taish," or second sight, and it is very common in Celts.

It seems almost superfluous to quote cases, of which there are veritably thousands fully certified and perfectly credible, for we cannot doubt that the faculty exists, and are equally clear that it lies in the borderland of psychology. Any attempt at explanation is so far extremely vague, not to say unsatisfactory.

It may be well here to condemn emphatically and unsparingly, once for all, that supposed scientific attitude of mind, greatly affected by some, which dogmatically declares that all it cannot understand does not exist. I may give instances of this later on, for these arrogant believers in their own *ipse dixit* are not uncommon;

and, entrenched in their ignorance, they refuse to listen to any evidence whatever. Fortunately, between this narrow, illiberal, and unscientific scepticism and the crude credulous beliefs of others there is a sane and safe *via media* of applied common sense. To this I will submit half a dozen illustrations of what I mean by this larger sense of clairvoyance, as personally known to myself, or from the testimony of old and reliable friends.

Many years ago my brother died unexpectedly in inland China. Two of his sisters-in-law, in different parts of India, saw him at the foot of their beds the night he died, and, not knowing he was at all ill, concluded that he had come to announce to them the death of his wife, their sister. It was not until nearly two months after that a letter arrived, by way of England, from which they learned that he had died that night.

The next two incidents illustrate a statement of Prof. Bray, " We photo our mental states on all the rooms we inhabit."

A curate of a Kensington church, when dining with me, said he had just come through a remarkable experience. He had taken a small, newly decorated house, and, retiring to rest on the first night, he knelt down to pray by his bedside. He was immediately conscious of a presence in the room, and looking over to the corner where his portmanteau had been lying, he found it had disappeared, the new wall-paper had gone, and in an old arm-chair an aged lady of malignant aspect was sitting, clutching a stick in her hand, which she was shaking violently at him, and evidently speaking, though he could not hear a sound. After a few minutes the vision disappeared, and the room resumed its normal aspect. Next morning he called on the house-agents to find out any possible explanation of what had happened, but they could give him no light. On his way home he met another curate, who, when he heard where he was staying, said: "That is an extraordinary house; it used to be in my beat, and upstairs in a bedroom lived a strange old woman over 90. She did not mind my reading the Bible to her, but if I attempted to pray she got perfectly furious, shaking her stick at me, and declaring she would not be prayed at." I narrated this circumstance to the greatest occult psychologist I knew in London, and he said that it was not at all likely that the curate had seen a spirit, but that impressions often seemed to be left on the local ether, which could be seen by clairvoyants. The curate who had the vision was a clairvoyant.

When I was staying with a lady in Cumberland we motored over to a beautiful old mansion which she had never visited. In the entrance hall, when sitting for a moment, she suddenly said to me, "What is that?" pointing to a corner of the hall where she declared there were two men violently fighting. I, however, could see nothing. Our hostess then appeared, and told us that in that corner of the hall, some hundred years ago, a father and son had fought.

We then went up into the library, and my friend, Lady ——, sat down at a writing-table to rest. "What is that man doing?" she said, pointing immediately to the wall near the door. I asked her what she meant, for there was no one there. She said, "It is a young man in a brown cloak, and he keeps putting out his hand as if he were taking books down from a shelf." "Oh," said the lady of the house, "I must show you his picture in the other room. That is a young monk who lived here generations ago, at which time there was a bookcase on the wall there, and many people have seen him."

I will now give two illustrations of seeing the future.

A great friend of mine, a clergyman's wife, belonging to a well-known family, wrote to me : " Will you explain why God shows me things that are of no use ? Some time ago I dreamt I saw a motor-car rushing down a hill, and the people all had their faces turned away from me. At the bottom of the hill it came in violent collision with a cart, and they were thrown out. A fortnight afterwards I got a letter from friends of mine who had been greatly injured in their car by such a collision at the bottom of a hill : had I seen their faces I could have warned them.

" Some time afterwards I dreamt I saw a lady driving in a victoria, but her parasol was over her face so that I could not tell who she was. As the carriage turned a corner, a hansom cab dashed violently into it ; the lady was thrown out and appeared to be much injured, but as I still could not see her face I did not know who she was, and could not warn her. I waited a fortnight, but could hear of no accident to any friend. I went down to Westgate-on-Sea, and a week after, taking up the paper, I saw that the wife of the Rev. R. C—— had been much injured by being thrown out of her victoria. She was a great friend of mine, and I could have warned her had I seen her face."

Many examples from Scotland could be given, and the evidence of large numbers has been collected in two volumes by Edmund Gurney, under the title " Phantasms of the Living " ; but these six instances will suffice to show that here, at any rate, we are in deep borderland questions. We are thus brought to ask, Does the future pre-exist ? To which there seems no possible answer but that in some sense it does. If there be no time, it is difficult to say it does not ; and yet it seems that the affirmative is quite beyond the capacity of our minds to grasp.

Clairvoyance also extends to seeing thoughts. Some sixty thought-forms are depicted by Mrs. Besant and Mr. Leadbeater in their book on the subject, of which we are told that every single one is drawn in colour from life. They are not imaginary forms prepared as some dreamer thinks they ought to appear, but representations of forms actually observed as thrown off by ordinary men and women, and either reproduced with all possible care and fidelity by those who have seen them, or with the help of artists to whom the seers have described them. They are on all sorts of subjects—for example, thoughts in church, on seeing a cab accident, on hearing Mendelssohn, at a lecture, of a drunkard as he struck down a woman, of a jealous person, of a man reading an account of a sad accident, of fright. I am told by a friend whom I have always deemed truthful that she can see thoughts, and that vague general ideas have confused edges, whereas direct purposive thought has its borders sharp and clear.

This thought-seeing is a form of clairvoyance of special character which it is vain to set aside. If truthful people say they see what is invisible to us we cannot regard them as necessarily lying or deceived because we cannot see it ourselves. At the same time we have no scientific cognisance of forms of thought, or indeed that thought has any entity at all. This, again, is at present in the borderland of deep mystery.

I may add that the late Dr. Baraduc, of Paris, could clearly see thought-forms and thought-waves, but found great difficulty in drawing them, which he thought was possibly due to their being in four dimensions. It appears that the quality of the thoughts determines their colour, the nature of the thoughts their form, and the definiteness of the thoughts their outlines.

Mrs. Besant has also given by clairvoyance some remarkable facts in the chemistry of radium which have since been proved to be true. Innumerable instances of clairvoyance are reported in this great war: wounds on certain days and in certain places have been seen and predicted accurately months before, and apparitions of all sorts have been seen, too numerous to mention.

Crystal-gazing is a variety of clairvoyance consisting of self-hypnotism, which brings the unconscious mind to the surface. In clairaudience we get similar phenomena. Both of these are more common amongst us, at any rate to some degree, than we are aware of. Both are to a great extent capable of cultivation, but there is no doubt that this is fraught with danger, of which we shall say more hereafter. These powers, indeed, seem to be budding or nascent faculties, which may be fully developed in some future state. At present all these borderland phenomena are exploited and degraded by charlatans.

The following is from Maeterlinck's "Unknown Guest":

"Jean Dupré, the sculptor, was driving alone with his wife, when suddenly, on the edge of a cliff, they heard a voice saying, 'Stop!' They turned, and saw no one, but the cries were repeated; at last the sculptor saw the left wheel of the carriage had lost its linchpin and was on the point of leaving the axle, when they would have gone over the precipice."

Was this voice objective or subjective? Personally, I can testify that there are times when it is impossible to decide. I have heard a voice call and shout as clearly as if it were objective, and have asked the friend with me if he had called, and then have found that the sound was produced by my own mind.

Maeterlinck asks, "Are these warnings due to subliminal consciousness, or are they spirit warnings?" One can only, of course, judge by the facts in each case. In the case of Dupré the warning was clearly providential, and one must judge that it was objective, in common with other visions and voices with the same results. Joan of Arc is a well-known example.

With regard to the warnings that are met with, Maeterlinck says, I think rather too sweepingly: "These premonitions are generally futile, but not always. A traveller arrives at an unknown town in the dark, and suddenly feels an irresistible impulse to turn and go away; he obeys, and next day discovers, had he gone a few feet farther on, he would have slipped into the river and probably been drowned. A traveller in South America descends a river in a canoe; the party are just about to sail round a promontory when a mysterious voice orders them at once to cross the river: this appears so absurd that he has to threaten the Indians with death to force them to do it; but they have scarcely got half-way across when the promontory falls at the very spot they meant to round it."

Dr. Hodgson, the eminent authority on Psychical Research in America, tells us of a dentist bending over a bench where he was vulcanising some rubber with copper, and hearing a voice saying, "Run to the window, quick!" He ran to the window, when suddenly there was a tremendous report, and, looking round, he saw that the copper had exploded, destroying all that part of the workroom.

Finally, we reach the question of double personality. Of course, we are all of us conscious in our normal condition that we are two persons, which not infrequently bear the likeness of the Jekyll and Hyde of Robert Louis Stevenson. But in true double personality one person only consciously exists at a time, and is ignorant of the presence of the other until he is replaced by its personality. I will give five instances of this, three of which are known to myself, and two to friends of mine. I may say that this double personality often includes so-called cases of possession.

The first was that of an educated Arab gentleman with whom I dined at the Holborn Restaurant by request of a doctor. His second personality (whose presence, I may say, was strongly resented by the first) did not begin to speak (in Persian) till the sweets came, and then wanted to know who I was.

I had a patient in Paddington, a very quiet Christian spinster, and was summoned to her suddenly at various times, when I found her lying on her bed shrieking blasphemies and obscenities containing words she could not possibly have ever heard, as she did not visit in the slums. Her sister would stand weeping at the foot of the bed, protesting that the voice was not her sister's. When she recovered, a time of stupor followed, and then she became her ordinary self.

In another case a woman of 34, clever, thoughtful, and of strong personality, alternated with a child of about 6. When she was the child, nothing would content this woman but riding on a rocking-horse, or playing with dolls for hours together, which she did with most childish delight.

These are cases I personally recall. The next was well known to a London publisher and to the daughter of a leading Harley Street physician. A Christian lady of rank in Germany, for nearly two years, at intervals, when sitting at table with friends, would suddenly begin to talk in a hoarse man's voice, saying all sorts of devilish things purporting to be satanic mysteries. Here again would be a certain amount of blasphemy and obscenity. Distinguished alienists visited her at the request of her relatives, but pronounced her perfectly sane, as indeed she was. After half an hour or so her natural voice would return, and she would go on with her meal or occupation in a normal manner. All her friends were greatly distressed at her condition, and earnest prayer was made privately and in churches for her recovery. Suddenly the manifestations ceased, and did not recur.

The last case was told me by a London physician who is a friend of mine. It is that of a Baptist minister thrown on to his head out of a gig ; he was carried home stunned and put to bed. In the morning, hearing no sound, they entered the room, but he simply lay in bed and smiled, answering no questions. Finding nothing was to be got out of him but smiles, they brought breakfast, which he would not touch, but turned his head away. Seeing water running out of one side of his mouth like a baby dribbling, they discovered that he had relapsed into infancy. He manifested the greatest delight when a bottle full of milk with the teat was brought to him ; he gurgled and waved his hands, and did everything but speak. He then continued for some months a perfect adult infant. His friends determined to restore him to his clerical duties, and carried him off to the chapel and up into the pulpit, and there placed him as if about to preach ; but he only leaned his head on the desk, and smiled and gurgled, and they found it was of no use. Some months afterwards he fell down some stairs when trying to toddle, and suddenly became the Baptist minister again. I believe this alternating condition has been repeated since.

These facts are borderland mysteries which cannot be denied on the mere ground of their improbability.

CHAPTER XIII

Other Psychical Phenomena

UNDER this head we propose to consider in a general way the region of the psychical borderland, with the exception of those parts which we have already studied under separate headings.

It is a territory which has passed through strange vicissitudes. In the earliest ages, like much else that was not understood, all unexplained psychical phenomena were regarded beyond doubt as supernatural and due to spirit agency. As the light of science dawned, much was brought within the range of certain knowledge, and with this its mystery disappeared; but much, of course, was still in the twilight, and this was generally declared to be either pure fraud or hallucination, and was left in cold neglect.

In more recent years there has been a distinct revival of the study of this subject, which is the borderland *par excellence;* and many scientists, some of them of the highest standing, heedless of the loss of reputation which they might suffer, have sought to place some of its phenomena within the range of scientific truth. They have not, however, been wholly successful, in spite of the weight attaching to their names. Sceptical colleagues unkindly declared that, though clear on scientific subjects, they were deluded as to these.

Then, with the discovery of the unconscious mind, of wireless telegraphy, of the X-rays, and a few other marvels, numerous fresh hints were given as to the *modus operandi* of many phenomena that perplexed people.

Moreover, as the pendulum swung from the material in Huxley's days to the spiritual in the time of Myers and Lodge, fresh theories of spirits—good and evil—came to the rescue, and, once postulated, have explained much that was otherwise inexplicable. Still, many facts, though undoubted, are unaccountable. There is no lack of rival theories as to their production, but nothing is as yet established on the firm basis of truth. It seems clear that the science of one generation is often a fable to the next, and that sometimes the fables of one generation are the science of the next.

The unsolved spiritualistic phenomena are said to include—

1. Physical phenomena, such as sounds of all kinds, alterations of weights of objects, movements of objects without apparent agency, the ascent of objects into the air, the conveyance of objects into and out of closed rooms, the releasing of mediums from every description of bonds, even from welded iron rings.

2. Writing and drawing; producing writing on paper untouched by any human agency, by a slate-pencil being laid on a table and a clean slate laid on the top in a well-lighted room, the sound of writing being heard, and the slate then bearing a long communication.

3. Musical phenomena; all sorts of musical instruments played without human agency.

4. The appearance of spirit and other forms, sparks, stars, globes of light, human forms in whole or in part.

5. Spirit photographs.

To investigate these phenomena the Society for Psychical Research instituted six different committees, as follows:

1. To study the influence of one mind on another at a distance.
2. To study hypnotism.
3. To study sensitives, clairvoyance, etc.
4. To study apparitions in haunted houses.
5. To study spiritualistic phenomena.
6. To study the history of these subjects.

The Society has apparently established that there are mental influences that can act at a distance; also, by an elaborate analysis of 17,000 cases, the fact of apparitions at death and other times.

Second personality is well established, and is often now regarded as demoniacal possession.

In the present state of our knowledge it is impossible to give an explanation of even such phenomena as have been observed and proved. They tend, however, to suggest, though not to prove, that the soul exists as a real entity independently of the body; that it is endowed with faculties still unknown to science, and is able to act at a distance without the intervention of the senses. Scientific ignorance, which constitutes the borderland, may arise from insufficient knowledge of facts, or from the unreality of the supposed facts with which science has to deal. In mediæval times nobody doubted the facts of alchemy, astrology, and witchcraft; they thought they knew (as some people do still) that stars influence human lives, and that a witch could turn milk blue.

Have we solved these problems yet? Not in the least, but we have found that the statements are untrue.

With regard to the phenomena of spiritualism, science is asked to analyse a series of supposed facts, many of which are to a great extent untrue, and arise either from fraud, superstition, or the vain projections of untrained minds. Besides these there are probably some real facts connected with hypnotic and other conditions which are only incomprehensible because as yet they have not been intelligently classified, and centuries may pass before this is done. There may be yet a third class of facts which are not subjective at all, but due to objective spiritual agencies.

We would point out here that great dangers exist in the modern experimental psychology now so much in vogue, and that all hopes of attaining exact results by it are illusive. Prof. Muensterberg tells us that the craze for it is an absurdity, for while in some few cases it has ascertained facts, the mind is so complex that the suggestions intended to be made by the experimenter are often so misunderstood as to lead to the most ridiculous errors.

In the spiritual borderland we must distinguish three classes of events: (1) those brought about by natural means; (2) those due to imposture; (3) those due to objective agents.

Maeterlinck points out that if we believe the dead survive and can come to us, we imagine it is the dead who speak; if we believe in spirits, we imagine it is they. Undoubtedly most of the so-called spiritualistic phenomena are due to the action of the spirit of the agent himself—but not all.

Much that is known amongst us to-day under new names is simply old superstition revived. Karl Pearson says: "The mediæval superstitions as to ghosts and necromancy are scarcely discarded before they reappear as theosophy and spiritualism." We may point out that, as a rule, in those séances which are conducted to support special doctrines and creeds (and not merely for the sake of the manifestations) all foolish pranks are absent, and the manifestations are more clearly objective.

And now we come to a point that cannot be over-looked. Prof. Hudson states that the exercise of spiritualism produces physical deterioration which keeps pace with mental decline, and which, no doubt, loosens all principles of morality and truth. As an illustration of fraud, he relates that, through a fraudulent medium, he has frequently had very affectionate communications from an imaginary sister, and has occasionally had a touching message from himself, the medium believing the name to represent a dead brother; the fact that he had never had a brother or sister made the communications all the more convincing! He adds: "No medium ever was powerful enough to produce his phenomena under test conditions, in the presence of a hostile and aggressively sceptical investigating committee." He also thinks that it is impossible always to distinguish between subjective and objective causes.

There is little doubt that in many cases manifestations of consciousness and thought and spirit can exist independently of cerebral activity, while the medium is in a profound sleep.

Recurring to moral deterioration, a well-known authority on occultism has recently pointed out to me that, so far as he knew, there were only six people in the kingdom who could really materialise spirits, and that they were all drunkards and liars, and would practically deceive whenever they could, although they really possessed some occult powers. All professional mediums cheat; but often (possibly) unconsciously, impelled by the desire to produce the phenomena that people are expecting.

Of course one can obtain evidences of psychical phenomena *ad infinitum*, but it is hardly worth the trouble, and one gets so tired of the subject, I suppose on account of the ineradicable taint of charlatanism that seems to corrupt the very atmosphere. In much of it also there is such an unholy lust of money-getting that it affords a great relief to turn to an authority concerning whom no such suspicion can lurk.

Sir William Crookes, who discovered thallium and invented the radiometer, believed at first that all spirit phenomena were trickery. In 1874 he began a serious inquiry into the subject, which resulted in his vouching for the following phenomena as facts :

1. The movement of heavy bodies without contact or mechanical exercise.
2. The alteration of weight in bodies.
3. The rising of tables and chairs off the ground without contact.
4. The floating of human beings in the air.
5. Luminous appearances.
6. Appearances of hands.
7. Spirit writing.
8. Phantom faces.

Of some of these phenomena, which are found in every country, we will speak in the next chapter.

Hudson points out that none of these and other instances of so-called spiritism constitute valid evidence that the spirits of the dead hold intercourse with the living.

There can be no doubt that some persons possess faculties and senses which we do not understand, and which form part of the exceptional inheritance of mankind ; but it does not seem possible nor desirable greatly to develop these now, though Asiatics have endeavoured to do so for centuries.

Divination is another very old form of psychic phenomenon. It is practised by crystal-gazing, shell-hearing, the divining-rod, Bible-swinging, automatic writing, sand, trance-speaking, palmistry, card-laying, dream interpretation, casting lots, drawing texts from the Bible or from Virgil (the *sortes Virgilianæ* of old times), inspection of entrails, study of footprints, omens, cries of birds, meeting certain animals; also by astrology, and by geomancy—divination by the lie of hills and rivers, which is very common in China, where no building can be erected without a certification from the professional geomancer that the position is a favourable one.

"To whatever power spiritualistic phenomena are due," says Maeterlinck, with justifiable sarcasm, "it is quite clear it dislikes to make itself useful. It readily performs feats of sleight-of-hand, provided we can derive no profit from them; it lifts up tables, produces flowers and hair, sets strings vibrating, gives life to inanimate objects, passes through solid matter, conjures up ghosts, subjugates time and space, produces light; but all on one condition, that its performances should be without rhyme or reason, and keep to the supernatural vein of puerile recreation. The case of the divining rod is almost the only one in which it renders any assistance to man, this being a sort of game of no great importance. Sometimes it consents to heal lungs, cleanse ulcers, strengthen limbs, and even set bones, but always as it were by accident, without reason, method, or object, in a deceitful, illogical, and preposterous fashion."

Certainly this nonsense revolts common sense; and much that is presented to our senses is deemed unreal on account of its ridiculous nature; and yet we may be wrong after all. We are naturally disposed to deny anything that seems nonsense, and if we read in Herodotus that a woman had a breast on her left thigh and suckled her infant therewith, we laugh at its absurdity, and yet such a fact was established at the Academy of Sciences in Paris at its meeting on June 28th, 1827.

Of course, it is said that whoever believes earnestly in the supernatural and desires signs and wonders is sure to see them, and will readily accept also the testimony of others as to their occurrence ; but this is rather shallow reasoning.

Various explanations, all unsatisfactory, have, of course, been given. According to Gasparin, psychical phenomena are produced by some fluid ; to Sir William Crookes, by psychic force ; to Lombroso, by the transformation of force ; to Porro, by the action of unknown spirits ; Prof. Richet wisely comes to no conclusion. A. R. Wallace and C. F. Varley, however, had sufficient proof to make them accept the doctrine of spirits. Prof. Hyslop thinks that no theory can explain the phenomena ; Dr. Brasset believes it is a question of medical biology of the nerve centres ; Dr. Maxwell finds the explanation in some force of an intelligent nature existing in all of us, forming with others a collective consciousness. Prof. Flammarion has no theory, but considers that the phenomena must be admitted as facts into the sphere of positive science.

There can be little doubt that it is necessary to postulate the action of some force at present unknown, which force must necessarily be either subjective or objective. Myers suggests that the phenomena are not truly supernatural, but supernormal.

Here, then, we must leave the whole subject in the twilight of borderland. It is an unsatisfactory chaos ; but the writer's one clear conviction is that, besides imposture and deception, there are undoubtedly unexplained facts of which some are due to subjective causes, and the others to some objective power of which we know scientifically little or nothing, but about which the revelation that deals with the spirit world has a good deal to say.

CHAPTER XIV

Details of Psychical Phenomena

I WILL here try to avoid any description of the more common spirit manifestations, only giving my personal experience at one remarkable séance. In the rest of the chapter I will present illustrations of psychometry, and of dowsing or water-divining; also the experience of friends on some kindred subjects, such as automatic writing, levitation, the magic pendulum, the astral body, the biograph or sthenometer, and other matters.

With regard to the séance, it was a very important one, and took place at a large house in Regent's Park in the presence of about seventy authorities on and students of these matters, who insisted on this occasion on conditions so stringent, to exclude fraud, that they could not possibly have been imposed had not the mediums, man and wife, consented to them. It would not be fair, perhaps, to name any of those present besides myself; I can only say that they were invited by the late Mr. Stead, and included his most eminent friends, certain professors from Oxford and Cambridge, distinguished scientists, leaders in theosophy, and other occultists, all undoubtedly keen for what they regarded as the truth and nothing but the truth. The mediums had, I was informed, in Mr. Stead's own house produced before him the materialised spirit of his lately deceased son, and he subsequently described this séance in Regent's Park as the most remarkable ever held in London!

With three other physicians, I was asked to attend privately, to examine the mediums physically. They had never entered the house before; and on arriving, the man was met at the hall door by two doctors, who took him into a room, stripped him, examined him for concealed articles, and dressed him in an old suit of clothes belonging to the footman. His wife was taken upstairs by two other physicians, dealt with in the same way with great care, and dressed solely in a skirt and blouse with stockings and slippers. The two were kept entirely apart throughout the séance.

In the drawing-room, two screens were placed across a corner of the room, leaving an opening in the middle over which we hung a curtain. Inside was nothing but one wooden chair, on which the woman medium seated herself. Then the curtain was drawn; her husband sitting in the audience with the others. We were all requested to take off our gloves, and hold each others' hands tightly, which we did for the space of about two hours. The light was dimmed, but one could still see. Certain doggerels and American revival hymns were sung—to my amazement—by learned professors and others, with perhaps more spirit than tune.

Mr. Stead then rose and said he had just received a message from the spirit world from Frederic Myers to say that he was expecting great things from this séance. Then the man "medium" stood up and petrified me by calmly stating that *he was not a medium at all:* he was merely a society entertainer who made no profession of occultism, but he and his wife would give such manifestations that afternoon that he would give £100 to any hospital in London if they could be reproduced under similar conditions.

To my astonishment, the audience, instead of rising in indignation and bringing the séance to an end, never moved a muscle nor said a word; and Mr. Stead then stood up and actually stated that these persons *were* mediums, but did not know it, or words to that effect. He or the man then proposed, as nothing was occurring, that we should pass within the screen, two at a time holding hands, and see that the woman was really sitting on the chair, and had no apparatus!

So we rose by couples, and passed in, including myself and my companion. I patted the medium on the back with my spare hand, and asked her to give us a good show, and she assured me that she would. When we were all reseated, the lights were further lowered, and soon we saw on the carpet, protruding from between the curtains, a bar as of luminous silver, then the shape of a human foot, the leg followed up to the knee, and then the curtain slowly parted, and, clad only in light gauzy texture, a human form appeared, shining all over as if rubbed with luminous paint, and coming forward, stood within six feet of me.

Mr. Stead now rose, apparently overcome with emotion, and told us who the figure (which he appeared to recognise) really was, stating at the same time that the medium was sitting inside the enclosure on her wooden chair. Then to my sheer horror (I can call it nothing else) the luminous figure itself spoke, and said in strong Yankee tones, "*No I ain't, I'm here.*" Even then, in the dim light, I could see no smiles on the faces of the learned men and women present. Three times did a figure slowly come out and return, and then, with minor manifestations, the séance came to an end, by the bursting open of the curtain, and the rushing out of the medium in her original skirt and blouse. I immediately congratulated her on her entertainment. Most of the others, however, to my amazement, declared that the séance was a really spiritualistic manifestation of great value !

I pointed out afterwards to Mr. Stead that any of the people who had passed within the screen could easily have taken in a roll of gauze and some luminous paint, but this he indignantly repudiated, and I lost whatever credit I might have possessed, in daring to make such an obvious suggestion.

I look upon this séance as the most remarkable instance of the collective hypnotism of educated people, strangers to each other, that I have ever seen ; and I cannot doubt but that the influence of powerful obsession frequently produces this condition, or that it is a much more common occurrence than we are at all aware of in great political, religious, and other gatherings.

Let me give an instance of it, told me by Dr. Bramwell. One day a brother physician called on him, and Dr. Bramwell said : " If you will come along with me I will show you something very remarkable." He then took his friend into the waiting-room, where a number of patients, who had come for treatment, were sitting in that vacuous condition that seems peculiar to such a place. Suddenly pointing with his finger, he shouted out : " Look there ! look there ! what is that on the middle of the table ? " All turned their attention to the spot and stared as he proceeded : " What is that Turk doing there, sitting cross-legged, smoking his pipe, on my dining-room table ? See ! look at him, he is rising from it ! " Their eyes were now all glued on the imaginary object. " See ! he is touching the ceiling, his head has now passed through, his body is following ; there now, he is gone ! Vanished ! " Then he asked them : " Did you see that man ? " And they all said that they had.

" Now," said Dr. Bramwell to his friend, " the importance of collective hypnotism is this, that to-morrow probably each one of these patients will be prepared to state in a court of law that he saw that Turk sitting on my dining-room table." If this be so and extends, as it does, to miscellaneous crowds, it accounts for the Indian trick of the boy disappearing up a rope thrown into the air. Sir William Barrett says that a psychologist tried to photograph the trick, and though the crowd said they clearly saw the rope and the boy in the air, when the plate was developed there was neither rope nor boy on it.

Turning now to psychometry, which consists of visions called up by material objects, I will relate two instances well known to me.

I handed a small gold cross belonging to a young clergyman to a clever lady in my consulting-room. As soon as she got it in her hand and pressed it to her forehead, she said: "Oh! how dreadful! What shrieks and sounds! This cross has most disagreeable associations, I will not hold it longer." And she gave it back to me. It belonged to the chaplain of a lunatic asylum.

I then gave her an ordinary-looking stone about the size of a small orange. Again she was horrified. "Oh!" she said, "this is full of wickedness; it is very, very old. I see wild people shouting and rushing about," and she seemed to describe some great panic. This was a stone I had myself picked up outside the walls of Joshua's Jericho; and it had just been laid bare, with scores of others, after being buried for three thousand years. It was probably one of many which had been thrown by hand from the mud walls of that ancient fortress, the whole of which had just been exhumed by an Austrian archæologist.

The scene of the other incident was the room of a physician who told me that he had discovered that he had the power of psychometry, of which hitherto he had been completely unaware. I took a gold pencil out of my pocket, handed it to him, and asked him to tell me its history. He described the friend who gave it me and told me many correct particulars about her. This puzzled me greatly, for, as I explained to him, the friend had chosen it in a shop, handed it straight to me, only touching it once, and I did not see how she could be so strongly associated with it. A clever psychologist who was with me gave me what I thought was the solution. He said: "He does not learn what he tells you respecting this friend from the pencil, but he reads the thoughts in your brain." The physician then said: "Ask me a question now of which you do not yourself know the answer." So I handed him an article belonging to my sister and said: "Tell me what she is doing at the present moment," of which I had no idea. He described her sitting in a small hall with an iron roof, on a platform with four other people, the table being covered with a green cloth; apparently at some meeting which one of the five was addressing. Subsequent inquiries showed that the main particulars were quite correct.

Dr. Buchanan advances surprising claims on behalf of psychometry. "It is," he says, "the science of divinity in man, whose faculty of intuition, by the art of this divine science, enables geologists to see the world in its formation, physicians to watch the progress of disease in its subtlest forms in the obscurest recesses of the human body!" "Time," he adds, "has no meaning for the psychometrist; the past and the future are to him open books." It is obviously not necessary to endorse Dr. Buchanan's rhapsodies to show that this art is certainly in the borderland of psychology.

Let us now turn to water-divination, of which I have some slight experience. A vicar whom I have known for twenty years is a great adept in it, and succeeded by its means in finding water for his house, which had been practically uninhabitable for want of it; there were no outward indications of the spring he so unerringly discovered.

Mr. Holt Schooling, the statistician, says of diviners that the proportion of their successes to their failures is much larger than can be ascribed to mere chance. Diviners are mainly employed by practical men who want water, and who pay them, and are satisfied with the result. It is quite possible that certain persons are affected by physical influences which do not affect others. Evidence shows that there is no power in the rod itself, and with this my clerical friend wholly agrees.

Sir E. Ray Lankester has no belief in water-dowsers, and has published his experience of what he calls their trickery. He seems to arrive at this conclusion by many unscientific assumptions and but few proofs, and personally I think the weight of evidence is against his contention. I speak of water-dowsing only; I have no knowledge of metal-dowsing.

The first mention of the dowsing-rod for minerals and water is in the year 1500, so that the art is of some antiquity. Here is a modern, well-authenticated example of success. Sir Henry Harben could get no water for his mansion at Horsham, in Sussex. He sank a well 90 feet deep, but it was dry; then he dug another in a different place 55 feet deep, on expert advice, with no result; then he sank a third through the Horsham clay 100 feet deep, but still no water was found. He then ran horizontal channels in different directions at the bottom of his big well, at a cost of £1,000, but the result was failure. Finally, in despair he sent for the dowser John Mullins giving him no information. Mullins walked about the estate until he stopped on a small elevation, and declared that water would be found 20 feet below. Two wells were dug on this spot through sandstone rock, and an immense supply of water was found at 15 feet from the surface.

Here is another instance. In 1887 the bacon factory of Richardson and Co., at Waterford, required water; they dug a well 62 feet deep at the most promising spot, with no result; then, by professional and geological advice, they had another bore made 292 feet deep, but only a trifling amount of water was obtained. The next year, at the bottom of the first well, they bored through another 612 feet of very hard Silurian rock, with diamond drills, but no water was obtained. The boring was further continued until a depth of 1,200 feet from the surface was attained, but it was a complete failure. Then, again on the best geological advice, another spot was selected, and a 52-feet bore was made; the result was the same. Messrs. Richardson were about to move their factory elsewhere when they were urged to try Mullins. He was sent for from Wiltshire, and was told nothing of what had been done. He asked no questions, but walked about holding his rod; at one spot, only a few yards from the deep-bore hole, the forked twig twisted over and broke in his hands, and Mullins declared that there was abundant water here 80 feet below the surface. The boring was begun where the rod broke, although it was considered a waste of money, but at a depth of 80 feet the water suddenly rushed up the bore hole; pumping was begun, and from that time (1889) an unfailing supply of 5,000 gallons an hour was obtained.

These stories could be multiplied, but we must pass on to automatic writing, of the fact of which I have abundant evidence. In some cases it distinctly appears to be much more than unconscious muscular movement by the unconscious mind, for drawings and paintings quite beyond the agent's power have been done automatically. With regard to letters presuming to be from Frederic Myers, Sir Oliver Lodge said, in 1910: "The one hypothesis which seems to me most nearly to account for all the phenomena is that we are in direct touch with some part of the surviving personality of a scholar, and that scholar is F. W. H. Myers."

Of the phenomena now to be considered I have no personal knowledge, but many of my friends have.

Speaking of floating furniture and people, Prof. Flammarion observed: "The phenomenon of levitation is to me absolutely proved, though it cannot be explained." Lord Lindsay, a former President of the Royal Society, before the Committee of the Dialectical Society, on July 6th, 1869, described how he saw D. D. Home, a medium, float out of one window and in at another, in Ashley Place, Victoria Street, 85 feet from the ground.

In 1906, at the Psychological Institute in Paris, a heavy table was lifted 20 inches from the ground by two people placing their hands upon it. A heavier table required more people. Often the table continued to rise even after the experimenters had ceased touching it.

Another old and simple illustration of unconscious muscular action is that of passing a string over the ball of the thumb and hanging a ring on a loop of it 18 inches long (the other end being caught up by the fingers). This magic pendulum, by unconscious muscular action, will oscillate to and fro in spite of all the efforts of the person to control it; it will rotate either with the hands of a watch or against them, as wished, or it will strike the hours of the day if suspended in a tumbler, or even point to the letters of the alphabet in a ring round the glass. Hung over a gas bracket instead of on the hand, it will not move at all. Even in 1736 Mr. Gray, of the Royal Society, fully believed that these motions would give a new theory for the motions of the planets, while later Prof. Ritter thought that in it he had discovered a new force which he called Siderism; and as recently as 1911 an able journalist told the public how the sex of eggs could be discovered by this pendulum. The planchette acts in a similar way, and so does table-turning.

The "astral body" seems another borderland problem. For the benefit of the uninitiated I may say that this astral body is the extremely tenuous and semi-material covering that clothes the soul, and thus gives it a human form, as seen in ghosts and all apparitions. The idea is that the spirit is without form and is invisible, the body wholly and truly material, and the soul clothed semi-materially by the astral body. It is quite superfluous to add that this is pure hypothesis.

Several serious, altruistic, and clever friends of mine, including one well-known physician, believe that they can detach their astral bodies while they are asleep, and project them to visit others, as previously directed by their thoughts. A baroness known to me, about to send her astral body to Scotland to visit a cousin of hers, sat on the scales during the process, and found she was half a pound lighter when it had gone. My only justification for recording such frivolities is that here, at any rate, there is no taint of conscious imposture; the lady is very clever, and firmly believes in the truth of her statement.

The biograph and sthenometer are most interesting instruments. Dr. Baraduc, of Paris, used the former, and I use the latter, which I find of considerable value in diagnosis. The former has been shown to scientists at the French Academy, and I myself have fully described it in the *Contemporary Review* and shown it at the Philosophic Society, and asked in vain for a solution of its action. Dr. Baraduc's instrument was simply a short bar of ordinary iron inside a glass globe, suspended by its centre from a silk thread. Hands placed outside caused this bar to rotate in various manners. I, however, much prefer my sthenometer, which gives similar results.

It consists of a balanced straw, 8 inches long, rotating on a diamond point over a circle inside a glass dome. If part of the human body (preferably the hand) is placed within an inch or two of the external glass, the straw slowly rotates for 60 or 70 degrees (8 or 10 inches) in obedience to some force emanating from the human body that is not heat, electricity, light, nor sound. I presume it is what is called the aura, and for convenience one terms it "nerve force." It is not heat, for the straw will often move much more freely if the hand be cold than if it be hot. It has been tested for electricity, and indeed examined by scientists in every possible way, to account for the undoubted movements, which are very characteristic, but the results have been uniformly negative. So far as I can personally make out, after many years' study of it, it seems that the general nerve force of the body is best measured by the right hand, while the left hand indicates any pathological deviations from it. I use two separate machines side by side, one for each hand, so that the two hands can be tested simultaneously. In any mental disturbances, such as true hysteria, fits, and insanity, the straw absolutely refuses to move with the left hand, though moving normally with the right; whereas in all cases of neurasthenia the left straw moves far in excess of the normal, and exceeds the right, though in health it is always a little less.

I think the only position we can at present occupy, if we believe that in many cases, at any rate, the witnesses try truthfully to describe what occurred, is that at which Sir Oliver Lodge arrived in a paper read before the Psychical Research Society. He stated with regard to various inexplicable spiritualistic phenomena he had witnessed, that while he was forced to admit the facts, he had no absolute explanation of them to offer, and would only suggest as an hypothesis that there was such a thing as vitality at a distance; he was convinced that the effects were not illusions, and that the phenomena really occurred.

My last word is as to the dangers of this study. A lady living in Devonshire from the age of 16 conducted all sorts of spiritual manifestations which nearly cost her her life, and left her a hopeless cataleptic. Dr. Baraduc died in an asylum in Paris. Innumerable other cases could be given, and a friend whose brother was one of the best-known occultists in America said he did not know of a single case where such study had been pursued without distinct deterioration of the mental, spiritual, and moral faculties.

CHAPTER XV

Biology

BIOLOGY is the greatest and the most difficult of all natural cosmic sciences. By the most difficult is meant the one in which it is the hardest to be sure of the facts. One constantly thinks that a clear understanding of some process of life has been arrived at, only to discover that further study reveals that it is still in the twilight.

Biology, which has largely grown into its present form since the publication of the "Origin of Species," absolutely bristles with borderland questions of all sorts, for in nearly every step we take in its study we leave the region of ascertained fact behind and plunge into the uncertain. From the prenatal formation of the germ-plasm to the dissolution of the body after death we hardly ever leave this dim region.

In the origin of human life the question of the mother's food in determining sex, and that of parthenogenesis, or the development of an unfertilised ovum, as well as the whole causation of sex, and the relative parts played by sperm (the male element) and germ (the female element), are all in the borderland.

When we reach the stage of the fertilised ovum we face fresh chains of mysteries; in fact, here nearly all is as yet unknown. Artificial segmentation of the ovum in certain animals seems quite easy, and the multiplication of animals and parts of animals artificially seems so far without limit, and suggests all sorts of perplexing possibilities.

Biology

Prof. Driesch, at Naples, has forced two embryos together at an early stage, and thus produced a single giant embryo. On the other hand, he has divided the fertilised egg-cell of a fish into four separate parts, and each of these four separate parts produced in due course a fish differing in no respect from others of its species except that it was smaller.

Prof. Loeb forced three eggs together, and the result was an individual much larger than the normal. This is possibly a clue to human giants. He also decapitated a marine animal having eyes and a nervous system and internal organs, with the result that the head grew a new body and the body a new head, so that the one became two. Encouraged by this, he cut another specimen of the same animal (a planarian) into twenty pieces, each of which produced a complete animal of reduced size. This was repeated over and over again, until hundreds of individuals had been produced from one, the last generation comprising individuals less than $\frac{1}{15000}$th the bulk of the original animal. He has also grown as many as six heads on a single planarian: these heads will struggle for the same piece of meat, regardless of the fact that the same body will receive it, whichever mouth wins; they will also pull in opposite directions so hard as to tear the piece asunder.

Prof. Locke has partially divided the embryo of a sea-urchin into two, and produced two adult sea-urchins joined together by a bridge of tissue, as in the Siamese Twins.

All this opens up fields of borderland questions.

One of Weismann's well-known dogmas is the non-inheritance by offspring of characteristics acquired by the parents during life. According to this, no degenerate stock will ever be converted into healthy stock by the accumulated effects of good laws, sanitation, and education. Such means will render individuals strong, but the same process has to be gone through again and again with each successive generation. This, of course, raises the question of how original characteristics and tendencies ever started, and is still a conclusion so imperfectly based on facts as to be classed as a borderland question.

Another unsolved problem is that of instinct, of which we must only give one or two illustrations that may be new to our readers.

Prof. Driesch says: "We do not know what the history of instinct is, nor do we know the factors concerned in its history; they present at present an insoluble problem." Here are one or two of such problems in the chain of causation in connection with this faculty.

Dr. Sambon, in his researches for the cause of a certain bubonic disease in the island of Trinidad, found that the small swellings which accompany it, and are caused by the presence of a maggot hatched under the skin, are due to a remarkable chain of causation. The popular belief is that the disease is produced by a mosquito, but as a matter of fact the maggot is found to be the grub of a very handsome and rare fly with a long, bright peacock-blue body: the difficulty is that this fly is never seen in the neighbourhood of man; in fact, comparatively few know of its existence.

The idea of the mosquito was dismissed by all doctors as absurd, its grub being a water larva and not capable of living in human flesh. Dr. Sambon, however, found that no amount of argument would shake the native in his belief that the disease was caused by a mosquito. He therefore searched in every direction to find the real cause, and eventually discovered that in certain remote places a plant grew, with magnificent scarlet flowers, each one forming a large cup the shape of a parrot's beak turned upside down. Each cup was constantly full of water, and was swarming with animal life ; in it were tadpoles of the small green tree frog, the larvæ of two species of mosquitoes, and of many other insects. Over the cup projected two peacock-blue seed-vessels.

Now, this flower is haunted by the very fly which causes the disease, and whose body exactly resembles one of these seed-vessels. A female fly places herself perfectly quiescent above the flower so as to counterfeit the two seed-vessels of the flower ; the mosquito, when it emerges from the larval state, flies up and perches on this fly in mistake for the flower. If the mosquito be a male, nothing happens, and it flies away ; if it be a female, it is immediately clasped tightly by the fly, which glues to its abdomen from twelve to fifteen of its own eggs, and then releases the captive, which flies away like an unconscious aeroplane loaded with bombs prepared for the destruction of human life. The female mosquito is chosen because it alone is furnished with a proboscis of sufficient strength to pierce the skin of man, and the moment it settles on its victim and makes a wound, one or more tiny half-hatched grubs from the attached eggs find their way into it, and in this way the maggot of a fly that is never seen in the neighbourhood of man becomes the cause of a human disease.

Again, flat-fish have recently had their eyes bandaged and been allowed to live in a tank with a pattern on the bottom, of bars or circles of colour. After a time the pattern of the bottom on which they lie is faintly but surely reproduced *upon their backs*, thus tending to make them invisible. An attempt even to imagine how this comes to pass only ends in failure.

The faith and courage with which insects remain perfectly still, relying on their protective colour or shape, and constantly even feign death, are most mysterious.

Dr. G. F. Browne, formerly Bishop of Bristol, saw a snake swim across the Ouse in Yorkshire ; a toad on the bank saw it coming, turned over on its back, and stuck out its four legs as if it had been long dead ; the snake passed it by, and when it had gone the toad turned over and continued its journey. In these instances, however intricate the *modus operandi*, we can see the reason for the instinct.

On the other hand, some adaptations appear to us to be purposeless, as indeed our own ductless glands were regarded as being until recent years.

There are glass-like transparent prawns that live in darkness at the bottom of the sea and look like solid pieces of the clearest crystal ; and we cannot conceive the value of such colourless transparency in the dark, any more than we can that of the brilliant gem-like colouring of the tiny sea-anemones that spend all their lives in absolute darkness on the under-surface of rocks buried in the sand.

Again, in Loch Fyne, in Scotland, there are transparent shrimps which form the special food of the celebrated Loch Fyne herrings ; they have on each side seven lamps arranged at even distances, each covered with a small transparent bull's-eye like a policeman's lantern. Sir E. Ray Lankester tells us that Sir John Murray showed him a hundred or more of these phosphorescent shrimps swimming in a large vessel in a dark room at night. He says : " We turned out the lamp of the room and all was dark ; then a gentle tap was given to the vessel, and each little crustacean lit up, as if by order, a row of seven minute lamps on each side of its body, swimming along meanwhile, and reminding one of a passenger steamer as seen from the shore, as it glides along at night with lights showing through a row of cabin windows. The shrimps' lights shone steadily for a minute or so, and then ceased, and had to be lit up again by signalling their owners by knocking on the glass. These little lamps or bull's-eye lenses are far more elaborate structures than those of the glow-worm."

Certain caterpillars are able to adapt their instinctive acts of spinning to any material that comes in their way, so as to bring it into correspondence with the product they have formed so far; they not only repair their weaving if it has been disturbed intentionally, but they also form an identical tissue, though using leaves or abnormal forms of plants they have never seen before.

Henri Fabre, the great French entomologist, passed his life amongst borderland wonders, such as this : The sphex wasp forms a burrow in which to deposit its eggs ; when all is ready it has to be closed carefully to make it safe for the larvæ which are to be hatched. But before being closed the burrow has to be provisioned with food, which must be animal food and must be living but not active, for it must remain there weeks before the larvæ are ready to eat it alive Now, there are several species of sphex ; one provides spiders for its offspring, another beetles, another caterpillars, and another crickets, and each sphex knows exactly where to sting its prey so as to paralyse without killing it. If a spider, the sting is delivered on the large ganglion which is the nerve-centre of the spider ; if a beetle, the sting has to pass to the nerves between the first and second pair of legs ; if a cricket, it must be pierced in three nerve-centres; if a caterpillar, one sting must be given to each of the six or nine segments of the body.

Prof. Alfred Binet shows the marvels of instinct even in single-cell organisms. (We must remember, when we speak of single-cell organisms, that since the revelations of the ultra-microscope none are known that contain fewer than a hundred million molecules.) He says: "The bodo is a single cell with a small tail, which combines in troops to attack animalculæ a hundred times as large as itself, like a pack of wolves attacking a horse. This large body is set upon by twenty or thirty bodoes, which eviscerate and devour him completely." "The didurnium knows precisely the position of the prey it follows, for it takes aim at the object of its pursuit like a marksman, and transpierces it with its sword-like darts."

Our five senses are not the only ones that exist. Blinded bats placed in a room intersected by threads will whirl round and round with lightning speed without touching one of them. A tortoise caught in the Pacific Ocean and thrown overboard in the English Channel as dying was fished up again alive three years later in the Pacific, still branded with the ship's mark.

Migratory birds from Africa revisit each year their particular home in London or Moscow. Pigeons carried from Holland to Spain and kept there for five years return home without losing their way. A dog left behind in Russia returned to France in three months—a journey that no sense of smell can explain. The limpet makes many excursions for food, but always returns to its own place on the rock.

We turn now from the mysteries of instinct to those of special sensation. The sense of touch is very distinctly a double quality. If I touch any object I receive a sense of roughness or smoothness. Let me dip my hand in hot water ; is it a sense of roughness or smoothness that I receive now ? No. Again, into ice water ; here I get the same class of sensation as from the hot water, but it is not the ordinary sense of touch. The ordinary sensation of touch is a sense of force, and the sixth sense is a sense of temperature.

There may possibly be a seventh sense, a mechanical sense.

Science says that certain cells are the cells of sight and seeing, but the eye only *appears* to see ; that sight is really farther back, and is probably located in certain brain cells. But philosophy says that it is farther back still, since those brain cells which are supposed to see can themselves be seen.

The logic of science is yet too superficial to solve these or kindred borderland problems.

The question of a lost central eye is still in the twilight. The facts are these : The human infant has no bone in the centre of its forehead, the place being covered by membrane stretched over the anterior fontanelle. It has also a pineal gland in the centre of its brain, of which the use was unknown. The common slow-worm has a nerve-trunk stretching from its pineal gland towards the forehead. The Australian lizard known as the sphenodon is the only living representative of the order Rhynchocephala of Mesozoic times: on account of its enormous antiquity its pineal gland has been carefully examined ; the superficial part of the nerve-trunk leading from it is found to be developed into the retina of a disused eye. We all recall the fable of the Cyclops. And these facts point to the pineal gland in man being the disused centre of sight of a lost central eye.

Another problem we shall consider is instinctive memory in reproduction. Dr. Lowe, in the *British Medical Journal*, says that the lasting effects of pairing in animals are to his mind conclusive, and he gives many instances from dogs, cats, cows, and pigs; also a remarkable case of a fair Englishman who married a dark Brazilian woman who had no children; twenty years after she had died he married a light-haired Englishwoman, who subsequently had a dark-haired son of Brazilian appearance. Dr. Neale tries to solve this problem by regarding the case as one of psychological imprint—which is not much of a solution. The story of Jacob's method of breeding striped cattle will be recalled in connection with unconscious memory.

Several cases are known to me where mothers who believe in prenatal impressions have undoubtedly succeeded in imparting very marked characteristics to their children by these means. The well-known case of Charles Kingsley's mother is a remarkable example. She believed that she was able to impress upon him during the prenatal period a love of nature and of the environment in which she lived; and in adult life, when Charles Kingsley visited the place, he felt he had been there before, and ever afterwards loved it.

It is only fair to add that Sir E. Ray Lankester disbelieves in telegony, which is the name given to the memory by which the offspring of a sire inherits characteristics of a previous mate of its dam.

CHAPTER XVI

Life Problems

LIFE problems are, of course, innumerable, and indeed we cannot fail to observe, with regard to the whole organic kingdom and its sciences, that facts are the exception, while surmises, hypotheses, unproved theories, probabilities, possibilities, and assumptions—all twilight dwellers—are the rule. We only propose here to touch on some half-dozen of its many problems.

We saw in the preceding chapter that biology is the highest and most difficult of all natural sciences. It is the science of life; and life is something the biologist is not able to make in the same way as a chemist can make the compounds which he has to study. Life is not merely a specialised arrangement of organic elements, for biology is not applied physics and chemistry. Life is something apart, and biology is an independent science. It is this that makes all researches connected with the subject so full of pitfalls.

The first problem, or borderland question, is, What is life? Some may think that it is about time that science gave us an answer, but, as a matter of fact, it has none to give, and this is still emphatically a borderland question.

Prof. Osborne, in 1909, enumerated six essential processes characteristic of life:

1. Renewal and repair.
2. Absorption of energy and performance of work.
3. Power of resistance to changes in the environment.

4. Self-defence from other organisms.
5. Growth and reproduction.
6. Memory and intelligence.

The first three of these processes are, however, to some extent shared by crystals.

Alfred Russel Wallace points out that the requisites of life are a regular heat supply, a sufficient amount of solar light, water in abundance, an atmosphere with gases of animal and vegetable life, and the alternation of day and night; but it may be noted that many animals and vegetables living in caves and at the bottom of the sea dispense with some of these supposed requisites.

In the last century a desperate attempt was made to solve the problem of life, and at the same time to exclude all heresies of vitalism, or the intrusion of spirit into the domain of matter, by boldly asserting that man was a machine and nothing more. Nowadays one has to look long for a scientist who holds such a crude idea, so archaic has it become. Still, we will consider for a moment the attitude of science towards it.

Prof. Driesch (1908) says: "Mechanistic explanations in all branches of functional physiology, so much in vogue twenty years ago and more, have failed all along the line."

Prof. Minot observes: "No mechanical explanation of life suffices; that it is a vital force is the only reasonable hypothesis, but the nature of that force is at present an entire mystery."

Science long insisted that there was nothing in the body that could not be explained by the laws of natural force; but this is entirely contrary to fact, and has been fully disproved. The erroneous idea is possibly grounded on the fundamental assumption of most mechanical scientists that as life is not visible, therefore it does not exist. The mechanical theory, however, is really in contradiction of all scientific methods. It is most inconsistent for scientific men to insist in one breath that no scientific theory can be accepted which is incapable of mathematical formulation and experimental verification, and in the next to adopt a mechanical and chemical theory of life the laws of which have not been formulated, nor the facts tested by experiment.

Prof. Loeb, in his "Dynamics of Living Matter," still regards living organisms as chemical machines consisting essentially of colloidal material which possesses the peculiarities of automatically developing, preserving, and reproducing itself. The fact that machines made by man do not possess this threefold power constitutes, he admits, for the present, a fundamental difference between living and artificial machines! He thinks, however, that nothing contravenes the possibility that the artificial production of living matter may one day be accomplished. Living organisms, he says, may be called chemical machines, inasmuch as the energy for their work and functions is derived from chemical processes, and inasmuch as the material from which living machines are built must be formed by the same means.

But Prof. Tait, an unprejudiced scientific observer of the highest class, regards it as absolutely unscientific to admit any mechanical explanation of life; and with him are the bulk of scientists.

Sir Oliver Lodge says that life is "something outside the scheme of mechanics, and outside the categories of matter and energy, which, however, it has the power of controlling."

Henri Bergson says: "I doubt if the evolution of life will ever be explained by mechanical force; obviously there is a vital impulse towards a higher efficiency, that which ever seeks to transcend itself—in a word, to create. Now, a force which draws from itself more than it contains is what is called a spiritual force." Life, to Bergson, is consciousness launched into matter, and develops into intuition or intellect ; intuition is the mind itself, and in a certain sense is life.

A few years ago life was scientifically defined as the potential principle or force by which the organs of animals are started and continued in the performance of their several functions, the vital forces being regarded as physical and spiritual.

G. H. Lewes defines life as " a series of definite and successive changes both of structure and composition, which take place in an individual without changing his identity."

Lord Kelvin regards life as " the power of directing and moving particles."

Life uses matter for its own purposes ; it is a force of nature, and though it only relates to nature in space, it is not itself anywhere in space. Life is not a substance ; so far it appears to be a mere system of negations, for while it is easy to say what it is not, it is impossible to say what it is. Spencer's familiar polysyllabic definition of it, so often quoted, is little more than a juggling with words.

Life appears to be able to act on and use only complex chemical compounds of a few classes, and not the elements directly. Nitrogen, for instance, the most essential element of food, has to be paid for heavily, in its compounds of meat, bread, etc., in which alone it can be used ; while all the time it is entering the body freely by the lungs in sufficient quantity in a single minute to feed the individual for the day, if only it could be retained.

Life is not an ordinary form of energy, but the director of all the class of matter which it both dominates and transcends.

Prof. Driesch says that " life is not really energy at all, for all energy must have quantity, but life lacks all the characteristics of quantity, so it is wrong to speak of vital energy." No one, indeed, really knows whether life itself should or should not be classed as a form of energy: Driesch and Lodge say "No"; others say " Yes."

Life being proved to be something not altogether physical, nor even derived from the common forces of nature, but, on the contrary, a something that can use them all and exploit them for its own ends, recourse was had to an extension of the idea of vitality as something common to all nature. For instance, Prof. Tait says that all kinds of matter are in a sense alive. " Life sleeps in the mineral, dreams in the vegetable, and wakes in man." There is no such thing, then, as dead matter; the keynote of the whole universe is life.

This idea, however, can hardly be called scientific, and only serves further to confuse thought as to what is really meant by life.

Ferments are very mysterious forms of life, and still more so since they are not, as once supposed, exclusively organic; there are metallic, vegetable, and animal ferments. Certain metals in a colloidal state can break up other bodies by fermentation. Colloid platinum can decompose alcohol; more curious still, prussic acid and other poisons that are toxic to organic ferments can destroy the metallic ferments of colloids. It is believed that metal may be poisoned, or even fatigued, or depressed, or stimulated, like a living organism.

Prof. W. R. Brookes, of the Johns Hopkins University, says that while it is nonsense to regard trees, rocks, and lakes as endowed with mind, it is only nonsense because we know nothing about it, and not because it is necessarily untrue, for it is not greater nonsense to assert that stones are conscious than to assert that they are unconscious.

Though, therefore, it may be possible that no impassable gulf is fixed between living and other matter, there certainly is a great difference between the two. Plants and animals can reproduce their kind: plants and animals can assimilate other bodies: plants and animals in a moment can change their characters, and become suddenly what we call dead; but inorganic bodies know no such properties.

G. H. Lewes rightly says: "The universe assuredly exists, but it does not live; its existence can be only identified with life such as we observe in organisms by a complete obliteration of the speciality which the term life is meant to designate; yet many have not only pleased themselves with such a conception, but have conceived the universe to be an organism directed by a soul like that of man, which they call the 'anima mundi'; but this is to violate all scientific thought."

If we may here be allowed to refer to the deepest psychological sentence ever written, "In Him we live, and move, and have our being," we shall find the three conditions of matter precisely defined. The highest class (the organic) live, move, and exist (in God); the next (water, wind, fire, glaciers, etc.) move and exist (in God) but do not live; the other class exists only (in God), and neither moves nor lives. Existence or consistence does not, thus, imply life in its full sense.

No one knows what are the simplest forms of life; protozoa are certainly not, and the name is therefore a misnomer, for they are complex organisms, and the protobion, which, according to Prof. Gregory, is the first living organism, is far simpler.

This brings us to the second problem, the origin of life.

We all remember that at the British Association meeting at Dundee life was supposed to be derived from the mineral world; and it is not a little remarkable that while the Bible seems to imply that life generally proceeds from God, no definite account of its origin can be found.

There are three theories of the origin of life to-day, apart from revealed religion:

1. That life has originated, and still originates, from dead matter.
2. That life originated from dead matter, but can no longer do so.
3. That life was brought to this world from another planet.

A prophet of the first theory was Dr. Charlton Bastian; Tyndall and Huxley adopted the second; Lord Kelvin the third. Lord Kelvin held that dead matter cannot become living without coming under the influence of matter previously alive; he says this seems as sure a teaching of science as the law of gravitation.

As a matter of fact, the origin of life is far more wonderful than any restoration of it, such as a resurrection.

The supposition that there is a guiding intelligence indwelling in living matter without interfering with its chemistry seems best to agree with contemporary science, and the creation of all living things by this supreme Intelligence is the one reasonable, believable, and uplifting theory of the origin of life, although it may not be regarded as scientific.

Natural science is very well aware that to it the mystery of existence remains unexplained; but as it must also clearly admit that everywhere we see evidence of design, we certainly cannot grant that life originated by a fortuitous concourse of inorganic constituents. The occupation of the earth by the higher animals and plants required a chemical and physical preparation of its surface, which took place first, so that lower forms of life could exist, and prepare materials necessary for the food of more highly developed organisms.

Science, which knows nothing of the origin of life, is equally ignorant concerning death. To it, death means simply that a certain amount of matter formerly controlled by life, when freed from this control, obeys exclusively the laws of physico-chemical causality.

We now turn to the question of the original basis of life force. It was supposed that the discovery of protoplasm, or as Prof. Beale better calls it "bioplasm," gave the answer. It was in 1840 that von Mohl of Tübingen discovered the substance eventually called protoplasm, but Kahn of Breslau first proved the identity of the substance in animals and plants.

Huxley, in his "Introduction to the Classification of Animals," says of protoplasm: "This particle of jelly is capable of guiding physical force, so as to give rise to the wondrous structures of the animal world." But, in his work on "Protoplasm," Beale truly replies: "Living matter is not jelly; neither jelly nor matter is capable of guiding or directing force of any kind; the capacity of jelly to guide force, which Huxley says is a fact of the profoundest significance to him, is not a fact at all, but merely an assertion."

Huxley supposed "Bathybius," the slime brought up in deep-sea soundings, to be the basis of protoplasm, but subsequently discarded it.

Living organisms were believed to have commenced in the sea, and the elements of sea-water to be the actual elements of living matter (of course apart from any special creation); but Prof. Kennedy Duncan points out that it is incredible that sea-water and air, through chemical action alone, could evolve into a living organism.

We cannot consider vitality apart from matter, for it is the inter-relation of life and matter, life being the power which produces vitality. We must not be considered too daring in assuming the truth of this much debated theorem, for the most recent trend of science has been in its favour; and indeed, though its problems are still unsolved, Prof. Driesch, one of our most modern authorities, considers that vitalism is fully proved.

" The facts of adaptation to changes of environment," says Dr. Whetham, " the restitution of injured parts in adult mechanisms, acquired immunity, the reproduction of complex beings by hereditary process, the marvellous properties of mind and consciousness, make it impossible for a growing number of biologists to regard them as chemical and physical changes, and have gone far to re-establish biology as an independent science; they have led to the revival of vitalism, or as it is now called ' the autonomy of life,' which comes back to us refreshed from its years of retirement, with a stronger claim to notice."

Let us now turn to another borderland question, the immortality of the germ-plasm, and kindred problems.

Weismann's theory of the continuity of the germ-plasm lies on the borderland of scientific knowledge, for his results are still open to discussion and his conclusions to modification. He points out that unicellular organisms do not undergo any natural death, and, since they are able to reproduce themselves simply by division, are immortal. Multicellular organisms must perish, and so are mortal, with the exception of the sexual cells within them, which, he says, are immortal.

Dr. Hartwig considers that Weismann's distinction between the somatic (body) and the sexual cells is not proven, and that his special germ-tracks are still hypotheses.

The endless life of the germ-plasm therefore, with Weismann's theory on the one hand and Dr. Hartwig's on the other, is still in the borderland of science.

Hartwig regards the development of the ovum (in all life, vegetable and animal) in its peculiar line as largely due to the influence of its environment, or epigenesis; but Weismann regards it as entirely due to the qualities it originally contains, or evolution. Here we come to the great problem of heredity, which is another borderland question.

Haeckel declares that the molecules known as "plastidules" possess memory, but that this faculty is absent from all other molecules. Heredity is the memory of the organic molecules. Even, however, if the immortality of the germ-plasm should be admitted, and complete material continuity should be shown in all forms of life, it cannot be scientifically proved in the case of mind or spirit.

It has been remarked rather unfairly by a religious critic that, "knowing nothing of the immortality of the spirit, science has invented the immortality of the flesh, and recognises the morphological continuity of the germ-plasm unbroken from generation to generation, which is, however, but one of the fairy tales of science." This is surely an instance of how much better it is, in all criticism, never to impute motives, but always to preserve an unbiased mind.

The duration of the existence of any series of beings seems to be in proportion to the character of the organism: the lower the structure, the longer the life.

It is curious that daily miracles never arrest our attention; they must be occasional even to be doubted. Resurrection, of which so much is thought and which is so widely denied, is not scientifically so amazing as the production of a chicken from an egg, which goes on every day; and yet the latter is never marvelled at nor denied, though the power which causes an egg to develop is absolutely unknown.

Our next question is a startling one. After the fact of organic life, as distinguished from the non-vital character of the inorganic, has been established, we are asked, Is there truly any radical difference between the two, organic and inorganic, and cannot one (apart for the moment from the question of life) be made to merge into the other? In a sense some facts seem to give an affirmative answer, but the question really remains in the borderland.

Prof. Czapek says: "It was thought that life force produced a host of peculiar substances that were never produced by non-living bodies, and these were called organic compounds, and the part of chemistry which deals with them is even still known as organic chemistry."

There is no doubt that the abundance of carbon compounds in living organisms, compared with their scarcity in non-living matter, forms a striking contrast; and the idea held was that carbon compounds could only be formed by synthesis in the living cell. "Organic," indeed, usually means a product formed by life; but in chemistry, organic compounds are those containing carbon, which may be formed artificially ; such a synthetic compound is therefore chemically organic, but inorganic in its ordinary sense. The French chemists were the first to show that organic compounds were for the greater part compounds of carbon.

In 1828 it was discovered by Woehler that urea could be artificially prepared in the laboratory from ammonium cyanate ; and so deep was the impression produced upon the scientific world that Prof. Dumas declared that henceforth no sharp line could be drawn between organic and inorganic chemistry. Not only so, but between the two there seems to be the intermediate phenomenon of crystal formation, which is no longer entirely of the one, and yet is not clearly of the other, for organised matter does not grow like a crystal by fresh material on the outer surface, but by the increase of all its parts.

Since the formation of urea, other products thought to be exclusively organic are now produced without the aid of life. In 1886 Emile Fischer prepared grape sugar from glycerine. Most important colouring matters of plants are no longer extracted from them, but from coal tar.

In spite, then, of the determined efforts of science to answer them, all the various questions of life which we have considered are seen to be still in the twilight, and such is the position, almost without exception, of any others that could be asked in biological science.

CHAPTER XVII

Evolution

THE difficulties in the path of the scientific investigator are nowhere more clearly seen than when we examine the fundamental terms used in science, and ask what they really signify.

The word evolution, for instance, has many and contradictory meanings, and if a man says he believes in it, no one really knows what he believes in.

Respecting the subject, let us note what Virchow says, that " we should never teach as a known fact that which is not a known fact ; e.g. we cannot teach as a conquest of science that man descends from the ape or from any other animal."

No one doubts that progression is the law of creation, but of its exact method we are still ignorant. One thing is certain, that each product was perfect of its kind, from the lowest to the highest. The idea of some sort of evolution is as old as Empedocles, and probably much older, and Aristotle states the position of Darwin almost as it is to-day when he writes that it is argued that " where all things happened as if they were made for some purpose, such as were not aptly made were lost, while those aptly united, by chance were preserved."

Evolution and Darwinism, therefore, are not quite synonymous terms, for Darwin gave his theory to the world in 1859, but long before this Lamarck had propounded a full theory of evolution. Although Darwin's theory has been with us for some sixty years, it is still in the borderland of science, for nowhere do we find a more perfect example of the application of the theory of probabilities as distinct from facts than in Darwin's "Origin of Species" and "Descent of Man." Darwinism itself, indeed, is amenable to the law of evolution, and has been continually changing under the influence of increasing knowledge.

The conceptions of Darwin seemed at first sight to destroy the need for an overseeing Providence in any act of creation, and the application to life of the principles of the conservation of energy led some to the exaggerated belief that all living activities could be explained away as mere modes of mechanical or chemical energy, which this law does not in the least imply.

Darwin's theories are really concerned more with the method than with the fact of evolution, which, as we have seen, was known in some sense long before. The first assumption of Darwin was that living forms had never been introduced into this world but by a common parentage; but the very fact that living beings must have had a beginning is a denial of this. The second assumption is very curious, for it reluctantly admitted the possibility that the first living creatures may have had no parents. Darwin, however, asserts, without proof and perhaps unwarrantably, that this process can never have been repeated.

The fundamental question is whether evolution is itself a *power* or a *process*. With the latter assumption true science has no quarrel, but, even then, evolution is in the borderland. Darwin's theory, however, was that evolution itself was a power or an inherent force, as distinguished from a mere process—the result of an external force and will.

"The whole process of evolution," truly says Tyndall, "is a manifestation of a power absolutely inscrutable, and beyond the intellect of man. Considered fundamentally, it is by the operation of an inscrutable mystery that life on the earth is evolved." As little as in the days of Job can man by searching find out the power; we do not even in the least know scientifically how species are differentiated, or the mind unfolded from its prepotent elements in the immeasurable past.

Huxley says: "If the fundamental proposition of evolution as a power be true, namely that the entire world of inanimate and animate is the result of the mutual interaction (according to definite laws) of forces possessed by the primitive nebula of the universe, then it is certain that the present actual world reposed potentially in the cosmic vapour, and that all the fauna of Great Britain to-day could have been predicted with as much certitude as we can say what happens to the vapour of our breath on a cold day in winter." He concludes, after much consideration, and with no bias against Darwin's views, that it is his clear conviction that "it is not absolutely proved that a group of animals having all the characteristics exhibited by species has ever been originated by selection." Nothing discovered or advanced since these dicta has upset their emphatic declaration that the process of thought has placed Darwinism not in the position of scientific fact, but of borderland hypothesis.

In many organisms we see an entire absence of any evolution or progression; perfection apparently having been reached long ago. In the oldest strata we find leaves and ferns exactly similar to those of the present day, while the first animals do not appear to be inferior species to ours. There are hundreds of varieties of highly developed trilobites and crustacea, some with as many as 8,000 facets in their eyes. Another curious fact is that some of the earliest forms of animal life are still living, yet unchanged; one of the oldest of these is the terebratula, which is now rare but still can be found at the bottom of Loch Fyne. Molluscs such as the Lingulæ, existing at the present time, are found in the earliest ages of the Palæozoic era.

Another difficulty of the whole theory of Darwinism is that it attempts to account for the origin of species by the operation of powers wholly insufficient for such results. Prof. Vogt points out that no anatomy or embryology has given us the slightest hint how the segmented nervous system of the Annellidæ could have been changed into the central nervation of the vertebrata; and yet this system is the first thing that displays itself in the embryos of the vertebrata.

I have already said that it is an undoubted fact that in life there has been a progression from the low and simple to the higher and more complicated organisms. It is also true that all fresh forms of life in the past were as true to their type as now; there was no mixture; they came and went with equal suddenness, which proves that organic changes of a profound nature do not require the long ages postulated by evolution.

On the other hand, certain strata display marvellous fertility in new forms of life. In one section of rock, the lias, we find no less than 1,850 creatures absolutely unknown before, and there is no evidence of any surrounding changes to cause this; nor have intermediate forms been discovered.

All these are direct contradictions of the theory of slow evolution by a struggle for existence, sexual selection, and the survival of the fittest.

Again, as the "Encyclopædia Britannica" points out,

" Another real difficulty of pure Darwinism is that fresh organs, only useful when fully developed, are of no advantage to an animal or plant in its incipient stages." This, to me, is an argument of great weight against their gradual evolution, of which, moreover, no trace has been found.

Again, involution in certain cases is found to be more powerful than evolution. All pigeons left to themselves revert to the original wild pigeon. The 4,000 species of roses all tend to recur to the original wild rose. The innumerable kinds of dogs return to the original type of the wolf hound, the fox, or the jackal ; all fruit returns to its original wild stock. Varieties can, of course, be produced by cultivation, but not species.

No culture of any sort can transform the apple- into the pear-tree ; and all the costly experiments of the Prince of Schaumberg to produce from the hare and rabbit a cross-breed for sporting purposes failed ; though the only difference between the two is that the rabbit brings its young into the world in a blind and naked state, and therefore lives in a burrow, while the leveret runs about immediately after birth, fully coated and with unclosed eyes.

The Darwinian theory is an attempt to replace the action of a creative mind by that of fortuitous circumstances, but the following incident is significant of Darwin's own consciousness of the difficulty. The then Duke of Argyll met the great naturalist in London, late in life, and on his explanation of certain adaptations to special functions, said : " Well, Mr. Darwin, I cannot see any explanation of such effects except the working of mind." Darwin paused, and then said slowly and emphatically, " That often comes over me with overwhelming force, but at other times——" and he shook his head. When the author of a theory doubts it himself, we are safe in placing it in the borderland.

It is not sufficient to hammer or file iron to produce a railway engine, or to chip marble to produce a statue; there must be a special mental influence to direct these forces to the required result; and any such direction with regard to nature must be inconceivably more intricate than in the production of any works of man.

Dr. Macfie, from whom I have quoted before, says: "The assumption made by almost all biologists that the first form of life resembled the simplest form of life now known, and by variation, etc., there sprang from this all the flora and fauna of the world, is so audacious as to captivate at once the reason and imagination. But have we any right to assume that any protoplasm could contain within itself such infinite capacity for variation, or can we conceive of such prolonged and extreme difference of environment as could possibly produce it? Moreover, how is it that we have still amœbæ which have not evolved at all? Here is an amœba and here is man. Can any sane thinker affirm that one amœba remained constant to type, while the other has, by its own inherent power, become fish, monkey, or man? We have really no reason to suppose that the offspring of amœbæ could in any number of generations become mammalian vertebrata. An imagination that can picture the origin of amœbæ from a fire mist and of a man from an amœba is capable of anything. The story of Genesis i. is infinitely more plausible than the usual evolutionary hypothesis of the origin of species; whichever way we turn we meet miracles, and there is no escape.

"Evolution is not proved; the question is still open; it has never been proved that we came from a fire mist, or that we are cousins of a monkey. An organic evolution is merely a great and plausible hypothesis, but it is impossible to conceive of any selective process (though acting for millions of years onwards) that could evolve a man from an amœba."

Dr. Noah Porter, a President of Yale College, says: "The evolutionist not only tells us what the spirit is, but how it and everything came to exist. Starting with the singular transformations in the dovecot and the capricious mixtures of the cabbage garden, it rushes back to suggestions of star days and nebulæ, stopping here and there to consider the progressive order of the fossils; finding everywhere in the world of life growth proceeding from simpler to more complex forms of beings, and the constant displacement of the weaker by the stronger. The true [Darwinian] evolutionist accepts the formulated laws of evolution as a living force which is competent to solve all the questions of science concerning the unknown, or he may condescend to accept a blind will of forecasting energy that exists in a simple yet immensely complex unformulated something, of which nothing more can be defined than that it is not definable or known; and that it must be constantly guessed at and never guessed right."

This satire is not uncalled for, for the evolution theories of Darwin and others have opened up more questions than they have answered.

Stanley Jevons, in his "Principles of Science," tells us that "the doctrine of evolution gives a complete explanation of no single living form; and while showing the general principles which prevail in the variation of living creatures, it only points out the infinite complexity of the causes and circumstances which have led to the present state of things. . . . Why anything, indeed, should be as it is rather than in some of the other infinitely numerous possible modes of existence, Mr. Darwin can never show. The origin of everything that exists is wrapped up in the past history of the universe. At some one or more points in past time there must have been arbitrary determinations which led to the production of things as they are.

" It is a question of profound difficulty on what grounds we are warranted in inferring the future from the present, or the nature of undiscovered objects from those we have examined with our senses.

" We can never be sure that the future will be as the present. We hang ever upon the will of the Creator, and all predictions, all inferences which reach beyond their data, are purely hypothetical.

" All our inferences of unexamined objects and times are made on the assumptions: (1) that our past observation gives us a complete knowledge of what exists; (2) that the conditions of things which did exist will continue to be the conditions of things that will exist."

As to the origin of species, no man has ever observed an instance of such origination; indeed, the question whether fresh species are now appearing or not is a borderland problem; we may instance the so-called measles in pork, the *Oinopota cellaris* which lives nowhere but in wine and beer, and an insect that lives solely in chocolate.

We turn now to the character of the struggle for existence, and the dictum, that has so long been accepted by the cultured mind, and was first of all brought into notice by Tennyson's " In Memoriam," that egoism is the supreme principle that governs animal life, and the supreme force in evolution. The author of the frequently quoted lines—

"Who trusted God was love indeed,
And love Creation's final law,
Though Nature, red in tooth and claw
With ravine, shriek'd against his creed"—

reproached himself in later years for singing so wildly; and I would fain believe that he must have suffered pangs of remorse in misrepresenting our foster-mother so shamefully, for a selfish scramble is no more a complete interpretation of Nature than is the opposite principle of unselfish surrender.

It would appear that only so long as an animal is unicellular is self-preservation its first and only law. The multicellular organisms, which include all living creatures but these first, show altruism in a most marked way as another law of their existence.

For instance, in the genus volvox, a group of microscopic fresh-water organisms, the behaviour is very complicated; these single-cell organisms form themselves into great green balls by joining their surfaces together as a co-operative colony. Each one that forms part of the surface of the large joint sphere has two flagella which pass through the membrane and swing unimpeded in the water outside; the cells each tightly hold one another, forming hexagonal figures like the cells of a honeycomb. Every separate volvox is at liberty to act within its own cell, but it has two protoplasmic arms, one of which passes through each side wall and places it in communication with the member on either side. It is probable that these side filaments act like telegraphic wires, for it is necessary that all these diminutive organisms be in communication with each other, that their united flagella may move together as oars, so as to propel the entire colony along as a unit towards fresh food, in obedience to a single impulse. In one form of volvox the female cells are all in one part of the ball, and the male in another; but besides these there are neutral cells not designed for reproduction, but simply for locomotion; these are equipped with one eye and two flagella, and perpetually move the great colony along with self-sacrificing labour.

Egoism thus gives place to altruism in the realm of the natural (non-moral), as well as in that of developed morality. I need not dwell upon the fidelity to communal rather than to individual interests exhibited by others of the lower animals, nor on the self-sacrifice that is everywhere developed in connection with maternity, but I will now draw an analogy from the vegetable world.

What do we find with regard to altruism in the history of a fruit-tree? The history of such a tree is in two distinct epochs, each of which is dominated by a principle the reverse of that which prevails in the other. In the first, self-interest is the rule; the struggle for existence at the expense of every surrounding thing is the cause of all activity. The young tree robs the soil, overshadows weaker plants, and tries to take away from other roots every morsel of nourishment; it is a greedy, unsociable thing, that gets all it can and never parts with any of its strength.

But when this has been going on a certain number of years, a most wonderful change takes place, and a flower makes its appearance, which is most strange in a tree which has hitherto borne nothing but leaves. But stranger still is the process which follows. What has been accumulated is now freely given out; the energies of the plant are now devoted to the whole process of flowering for fruit or seed, a giving away of life substance in such a manner that no return will ever be received. With many a plant it is the giving up of all the life substance, and it perishes when the process is finished; but in every case it is exhausted and growth is interrupted by it.

The tree has been used by the great Teacher when He says that a man who lives a life in his lower nature of egoism is like a tree that bears nothing but leaves; whereas, on the other hand, the characteristic of spiritual life is fruit-bearing, which is wholly altruistic. A point in the analogy to which one may call special attention is that the very blossom of the tree is evolved from that which but for some mysterious transforming power would have been a cluster of leaves.

With regard to ants and allied species, Prince Kropotkin says: "If we knew no other facts from animal life than what we know about these, we might already safely conclude that mutual aid and individual initiative are two factors infinitely more important than mutual struggle in the evolution of the animal kingdom."

The same conclusion has been reached by Prof. Kessler, of Petrograd: "I obviously do not deny the struggle for existence, but I maintain that the progressive development of the animal kingdom, especially of mankind, is favoured much more by mutual support than by mutual struggle. All organic beings have two essential ends, that of nutrition and that of propagation. The former brings them to a struggle (egoism), while the need of maintaining the species brings them to support one another (altruism); and I am inclined to think, in the evolution of the organic world, mutual support amongst individuals plays a much more important part than mutual struggle. At the beginning we find there is no mutual support; the unicellular organisms lived at first absolutely self-contained lives; there was unending reproduction, not by mutual support, but by divisions of the organisms and unceasing conflict. But from this point onwards the whole history of creation is the record of successive combinations for mutual support, each one of which has been a victory over egoism.

" We have seen how these simple organisms have been found, first combining in colonies and then in associations of two or three classes and numbers with different functions ; then in organisms more and more complex, until at last we reach human beings, each one composed of millions of living cells having diverse characteristics but all working for mutual helpfulness by the aid of one controlling spirit."

The survival of the fittest is the great watchword of Darwinian evolution, but it seems forgetful of the fact that the fittest may not be a higher type, but a lower than that which preceded it. Evolution by natural selection may just as easily lead to retrogression as to advancement.

There is, however, no doubt that Darwin's evolution was in one way a step in advance of the former mechanical theory of life, for by evolution the inward unity of a living whole replaced the pseudo-unity of a machine.

The ultimate position of the strictest evolution today is that in the first germ lurked a potentiality of all species, which evolved themselves, without external creative force, by the powers within, so that a complete " Zoo " was packed in a particle of protoplasm. This is much more incredible than that a shirt should evolve itself out of a cotton-seed.

A philosophic evolutionist of this type, picking up a flint by the river Somme, decides that two or three chips upon its surface are the product of mind, and that the flint is an arrow-head ; but the same philosopher who can see evidence of purpose and mind in three chips on a flint is obliged by his creed, if a strict Darwinian, to believe that he himself was produced by fortuitous circumstances, which can make a philosopher, but could not possibly make a flint arrow-head.

In Darwin's time "variation" was the watchword, but since then the idea of "mutation," or changes by leaps and bounds, which we owe to Mendel, the Hungarian monk, has been introduced. These variations *per saltum* were quite unknown to Darwin, and give a decided check to the more confident speculations of his newer prophets. Mendelism shows that Darwin has not said the last word on evolution.

As we have seen, in its fullest sense, Darwinian natural selection is the negation of all teleology. There is no design that can involve a constant haphazard change both of individuals and environment.

There is also this difficulty, that all organic structures must begin to grow before they can begin to work, but their ultimate form is not made *by* their work, but *for* their work. They are therefore the result of design and mind, and not of chance. When we look upon an elaborate piece of mechanism, we at once affirm that it is human mind materialised. The evidence of purposefulness in living organisms suggests far more strongly that some unknown principle of design must have been at work from the very beginning.

In connection with this subject, Bergson's view is that instinct, and not reason, brings us into closest touch and most direct relation with what is most real in the universe, for reason has to do with matter, mechanism, and space, whereas instinct is most in touch with the flow of life that constitutes the universe, so that Bergson's arguments are like the familiar theistic arguments from design, only the design is mostly left out. They are a great revolt against any reliance upon the impotency of naturalism, which his theory of primordial superconsciousness leaves far behind. "In evolution," he says, "there is no doubt there have been crowds of failures, and two lines only seem to have led to success, the arthropods (insects) and the vertebrates. At the head of the first we have instinct in its most marvellous forms; at the head of the second, the human intellect."

The truth of physical evolution or progression is shown by the fact that the prenatal growth of man takes place on lines identical with those of other animals; indeed, in the human embryo the heart is sometimes undeveloped; it may remain as the heart of a reptile with only three chambers, or as the heart of a fish with only two. Each organ, however, it must be remembered, is perfect for its purpose.

This, of course, gives no support to Darwin's theory, nor any light on the formation of man. An external creative power was needed for the great mutations in every step of his history; for no single cell, as Prof. Hoppe points out, ever varies from, or can produce anything but, a cell of its own species. Human creative skill in machinery has given rise to a series of graduated forms that seems to be the parallel of the great series that we find in nature. Now if, from the similarity between them, we can logically infer that both series are the outcome of intelligence, are we at liberty to ignore the fact that the intelligence which has wrought in the one case appears to have pursued precisely the same methods which it has pursued in the other?

As to the feeling that such a concept of the Creator is less noble than the traditional one, one can only say that it is wiser, as well as more humble, to frame our thoughts of the Supreme Being in accordance with what is revealed of Himself in His works rather than according to notions of our own of what He ought to be.

Great battles have been waged and will still be fought over evolution and epigenesis; evolution maintaining that all growth is of parts already existing in the germ from the beginning, while epigenesis teaches that the parts are freshly developed from without by the power of life and may be entirely new; and this latter theory is rapidly gaining ground.

"With my own hand," writes Prof. Pritchard, "I obtained all the elements which I find in an egg and in grains of wheat, out of a piece of granite and the air which surrounded it, element for element. It has been one of the most astonishing results of modern science that it can unmistakably trace all these elements also in the stars; but no chemist has ever yet witnessed the evolution of a living thing from these lifeless molecules of matter and force."

It is now widely believed that a fresh force of life, and not merely chemical arrangement, produces the development of the ovum, and by this power forms one organ after another. This is no mere unfolding of what existed already in the germ in a smaller form; there is no evolution in the old meaning of the word. If the above be true, the development of living organisms is due not to an unfolding of what is already there by the forces of nature, but to epigenesis, which in its turn is due to vitalism, or according to Aristotle, who was the first vitalist, the power of life.

When we remember, however, that each fresh human being bears indelible marks of his special ancestry both in body and mind, we feel that he is not absolutely a new creation by the power of life alone, as epigenesis would imply; neither could he be wholly a product of evolution from the ovum. The truth, though confessedly beyond our mental grasp, appears to be that he is in some way a product of the two. While, therefore, we look on epigenesis as the main factor, we must not deny the force of evolution as seen in the traces of ancestry

CHAPTER XVIII

Medicine

HERE, as at every point where we touch life, unsolved questions and the borderland twilight surround us.

In "The Force of Mind, or the Mental Factor in Medicine," I have already written a book dealing in effect exclusively with this subject; and it will suffice to adduce enough evidence to show that in medicine, as distinct from surgery, borderland questions abound.

I have made, in the work in question, a determined attempt to bring out of the borderland into the light of science a large number of questions connected with faith-healing and suggestion, by explaining the existence and action of the unconscious mind. I am glad to say that most of these explanations are now received as facts.

No limitation of the power of the unconscious mind has as yet been shown. It is this power which is in fact the surgeon who knits all bones, repairs all injuries, restores more or less many structural and general defects, and protects the body; this also is the physician who at the onset of every disease produces the symptoms which characterise it, and which are mostly of a protective or curative order; and this, again, is the power that governs every physical and physiological process.

If the microbe of pneumonia should invade my system and proceed promptly to poison me after its malignant manner, my resident (subjective) physician (the unconscious mind) at once gets to work to neutralise all the evils. My temperature is raised to a height which weakens or kills the germ ; I lose all power of standing or sitting, and thus the unconscious mind puts me to bed ; it then quietly removes my appetite so that I can only take liquid food. It starts perspiration to keep my heat within reasonable bounds, a cough to remove any accumulation in the lungs, and rapid breathing for similar reasons ; and by the time the objective physician arrives with his best bedside manner, he finds that nearly all that is needed has been already done by the unconscious mind. Of course, he proceeds to bow down and burn incense to the far-famed goddess Nature, a being who he well knows does not exist, but whom he prefers to invent rather than face the reality of the unconscious mind.

Turning from these generalities, I will touch on one or two borderland questions.

Scars, crosses, or initials can be made to appear in the skin in some sensitives by suggestion; and well-attested cases of stigmata are recorded, where a close resemblance to the wounds of the crucified Saviour appear on the body of the ecstatic; but these so far are inexplicable.

We must put into the same category many charm-cures, the facts of which are clearly proved; and those of Lourdes, and other shrines and relics. I will give one illustration of a Lourdes cure.

A workman, Louis Bournett, had lost the sight of his right eye for twenty years; Dr. Douzous considered the case incurable. One day the man rubbed his blind eye with some muddy Lourdes water; he uttered a loud cry, and his sight was soon restored. He met the doctor and told him he was cured. "Impossible!" said the doctor; "you are incurable, my treatment cannot restore your sight." "It is not you who cured me," said the man, "it is the Virgin." The doctor shrugged his shoulders, drew a note-book out of his pocket and wrote a few words in pencil. With one hand he closed the man's sound eye, and with the other held the pencilled scrap before the blind one. "If you can read that, I will believe you." Bournett read aloud: "Bournett has an incurable amaurosis, and it will never be better." On this evidence Douzous and Dr. Verges of Tarbes deposed that this was a *bona-fide* "miracle."

Faith-healing is very old; we get traces of it among Accadians long before the time of Abraham, followed by the Babylonians, Egyptians and others. The power that effects the cure is undoubtedly subjective, though the process is still in the twilight. This subjective force (called faith) is stirred into curative activity by agents as various as medical instruments such as thermometers, bits of wood or metal or keys, incantations, charms, witchcraft, devil-worship as seen in Zurich and in Africa and the East, idols, impostors such as Dowie of Chicago, sacred relics, visions as at Lourdes, and by the sacred beliefs of the Christian faith.

In the physical cure only, the object of belief seems indifferent, provided it is sufficiently powerful to excite the curative faith of the individual; but the full benefit received, including the moral and spiritual results, and the blessing or the curse which the recovered health may bestow, depend largely on the object on which the faith rests. At Mannedorf, on Lake Zurich, Pastor Zeller, the successor of the well-known Dorothea Trüdel, cured all sorts of diseases by divine healing, but he remarked to me: "The devil cures them just as well at the end of the lake." On inquiry I found that numbers were "cured" there by incantations, and dancing with curious rites round oak-trees. The physical results at any rate were indistinguishable from those of Pastor Zeller's cures.

Cases of possession, of which I have spoken in Chapter XII., are also medical borderland questions. I am personally fully convinced that certain cases seen by me in private, of mania or frenzy, cannot be scientifically accounted for without admitting the possibility of the possession of the human body by a spirit other than its own. I am quite aware this is a highly questionable statement to make, but I feel sure that any trained thinker, having had my experience, would find difficulty in coming to any other conclusion. What I refer to are not ordinary cases of mania or lunacy, but such as I have described in Chapter XII., where quiet Christian ladies are seized with raging spirits of outrageous blasphemies and obscenities, and especially a mad hatred of God, which all disappears when the attack is over.

I can recall several other such cases, which to me seem conclusive of the possibility I have suggested. One is that of a most respectable and God-fearing Quaker from the north of Ireland—a well-known leader in all good works from his youth up. He used apparently to be frequently "possessed." At such times he would not only rave with bitter hatred against God, grind his teeth with rage till they broke, but shout such appalling blasphemies that his two highly paid male nurses both gave me notice: they could not stand it. This is the more remarkable as these were well-trained men, accustomed for years to bad language of every sort; but the blasphemous obscenities were so exceptionally vile as to be unbearable.

Profound melancholia is sometimes very mysterious in its onset. In this great war such cases have been common. All that one patient could keep repeating, in profound self-reproach, was: "I saw a shell, ducked my head, and it killed my friend," and this one incident seemed thenceforth to fill the brain to the exclusion of all else.

Such wounds of consciousness as distinguished from true mental disease, forming all varieties of nerve disorders where the ego itself gets wounded, are not yet scientifically understood.

In medicine the indubitable effect at times of microscopic doses of drugs, such as were formerly given in homœopathic practice, is a borderland problem; as is also the true *modus operandi* of curative serums.

All so-called empirical as distinguished from rational remedies raise borderland questions.

These remarks are purely fragmentary; but even these few words will show that the science of medicine is full of borderland mysteries.

CHAPTER XIX

The Organic and the Inorganic

THE organic differs from the inorganic in the fact that the former is concerned with life alone, which is immaterial, and the latter with things purely material. This unknown quality of life vitiates and obscures all our reasoning, and makes all organic questions more or less borderlands.

No doubt, as we have seen, many a desperate and despairing effort has been made to escape from the problem of "vitality," or spirit acting directly on matter. Morrison's parallelism, the Cartesian theory, the mechanical theory, to say nothing of monism, have all been efforts to destroy the spectre of the union of spirit and matter, and to show that there is but one entity—the material; that all mental powers and so-called vitalism are but unusual results of the union of mechanism with chemical explosions.

But what a surprise lay ahead for the monists, what an unexpected triumph, which, while destroying all their premises, accepted their conclusion by asserting that monism was true in a new sense. For, as we shall see, the present trend of scientific discovery is that monism is the final truth, and that there is but one entity. But, alas for Haeckel *et hoc genus omne*, this one entity turns out to be spirit, and matter disappears in its final molecular analysis. And yet we all felt at the time, in turning from the organic to the inorganic, that we were leaving the doubtful for the certain. How great was our relief at coming to the end of puzzling life-problems and reaching something solid and concrete in the material sciences. As for the abstract sciences, with their pale shadows, we were not surprised if they were borderland and unproved, for they had to do with the mind, and with life in its highest forms. But the material seemed good, solid, and satisfactory ground, where facts were as clear as day, visible and tangible; electrons and ether being then, fortunately, unknown.

Alas for the days in which we live, when all this fair prospect has been shattered, and, like a baseless fabric, the material world melts away, and "leaves not a wrack behind"! This indeed, by the way, we are told by scientists, may happen literally any day.

What, then, is left to us? Force? But what is force? Power that is almighty. Surely not God? And yet, what else can it be? When the material world is analysed into absolute almighty force, God is seen to be all, and absolutely and literally in all! Is this a truth of religion or science, or is it the real union of the two, and are we at length reaching ultimate truth? To these tremendous questions we seem irresistibly, but by no means voluntarily, drifting. Many a kick and many a struggle is being made by conservative scientists to avoid being sucked over the edge of the fall, the stupendous fall, of human pride. We are already in the rapids above our Niagara; we try to hold on to the solid shore of the material; it crumbles beneath our fingers. What shall we—what *can* we do, but resign ourselves to our happy fate, and, resisting no more, find at length, in all science, light and truth and love?

The "cold starfish finger" of a bygone materialistic science seems now wholly out of date; and the universe and its Maker and its ultimate product, man, tend to form one harmonious whole. Is this a fantastic dream, unworthy even of these poor pages, and, above all, unscientific? All we can say is that we have found it endorsed in one way or another by the highest scientific authorities.

And now perhaps we shall begin to understand a little more clearly why this book touches in so many parts upon religion. If it be asked, What has religion to do here? the answer is now plain before us, and stares us in the face in all branches of modern science (though many may not as yet have grasped it); in all the facts of molecular physics; in loosening our hold on the seen and tightening our grasp of the unseen. The material is going or gone, yet the spirit remains; and I repeat that if force be all, the word "Almighty" not unfitly describes it, and His eternal power and Godhead are, in these last times, being irresistibly demonstrated in what was once the most unlikely quarter—that of science.

It is thus we begin now to perceive from the leadings of science, in a new way, that the One in whom "we live and move and have our being," of whom we have thought so little and for whom we have cared even less, is "not far from every one of us," and indeed constitutes, in the expression of His force, the whole universe around us, as well as our own most paradoxical selves.

CHAPTER XX

Matter

In this chapter we shall glance mainly at molar, and in the next at molecular, physics, though it is impossible to draw any exact line between the two. We shall also endeavour to discover in each how much solid ground is left for the scientist to stand on.

As pointed out in the last chapter, scientists used to turn with a sigh of relief from studies of the invisible and of spirit to the visible *terra firma* of material objects, and monism was invented to prove that there was nothing else but matter in the universe.

We have briefly indicated the shock experienced when scientists found the solid ground absolutely dissolve beneath their feet. Their true feelings are only comparable to those of a party of shipwrecked sailors who have taken refuge on a small iceberg, but who discover, to their horror, that in its southern drift it is being rapidly dissolved, and that nothing remains for them but the ocean. So to our scientists the solidity of matter has gone, and nothing remains but an ocean of uncertainty, in which all their previous concepts have been dissolved.

Du Bois Reymond says that "in the comprehension of force and matter the human race has made no true advance for two thousand years; nor," he adds, "will it ever do so." He is perhaps injudicious as a prophet, but though many years have passed since this utterance, Prof. Driesch, one of our most modern authorities, does not reverse this judgment, for he says: "There does not exist at present any theory of matter which can claim to be true; that is, there are contradictions in every theory of matter, and there are always some points where we are obliged to ask for further information, and receive no answer."

There are, of course, two possible views of matter: one, in which a substratum of the material exists objectively; the second, in which all that we conceive of matter is derived from our ideas of time, space, and energy. No wonder, then, that it is hard, very hard, to say what matter is.

Perhaps the best non-committal definition of matter by scientists is "anything which occupies space"; and yet, of course, the only thing that really does occupy space, the luminiferous ether, is declared not to be matter at all.

According to one view, there are three entities—matter, ether, and energy. We no more know what matter is in itself than what are ether and energy, and it is convenient for scientists to say that the problem only concerns metaphysicians.

Our concept of matter is inseparably connected with our concept of force. Our minds form this concept from their sense-perception of muscular effort. But the fact that we have a special muscular sense is only an accident of our bodies; it is possible that the electric fish, if a philosopher, would know matter in terms of electricity.

Clerk Maxwell writes of matter: "We are acquainted with matter only as that which may have energy communicated to it from other matter, and which may in its turn communicate energy to other matter." With regard to energy he says that we only know it "as that which in all natural phenomena is continually passing from one portion of matter to another."

But this simply defines matter in terms of energy, and energy in terms of matter, and we learn nothing by it.

So far as our modern knowledge goes, there are but two objective influences in the physical world—matter and energy. Scientists say the quantity of neither can be altered, but this they cannot prove.

Until 1895 it seemed that physical science had defined the limits attainable in our knowledge concerning the sciences of matter and energy; there seemed little more to do but to fill in the details, and we were still left with something material, and had an idea that we had arrived at the truth. But at that date, when W. Röntgen, of Munich, accidentally discovered the X-rays, a new series of phenomena revolutionised the whole outlook, and something like chaos supervened.

Dr. Macfie further destroys all idea of the material when, speaking of matter and force, he says: "Nothing more spiritual than matter can be conceived. . . . Matter is really energy, and nothing more." He proceeds: "Water, steam, and ice are not different forms of one substance, but interchangeable forms of energy. . . . Matter, then, is force and nothing but force. . . . If we be asked what is meant by force, we reach a spiritual realm. Force in its ultimate analysis is conscious motion. . . . Conscious movement and a new conscious phenomenon are essential to the concept force. . . . Force necessarily connotes conscious movement. We cannot empty the idea of force of its psychological significance. . . . The moment we identify matter with force we identify it with conscious will and conscious Being; there is no way out of it. What was formerly called the substance of matter is now known to be force, and the force is recognised to be the soul or will of God."*

Much of this has been stated in other words as the opinion of Sir John Herschell, Schopenhauer, Herbert Spencer, and others. The quaint old couplet—

" What is mind? No matter.
What is matter? Never mind "—

is thus disproved, if matter at length be resolved into force, and force into mind.

But energy, to some thinkers, wants a basis, and though the luminiferous ether was by no means intended to be pressed into such a service, yet it was there, doing nothing. Why should it not also be a basis of matter? And thus the latest cosmic theory regards the formless ether as the ultimate basis of matter. Perhaps this universal ether was originally endued by its Creator with energy, uniformly distributed throughout it, and the development of the material universe may be therefore attributed solely to changes produced by energy in the original ether. Exactly how the change of energy distribution in the ether accounts for the origin of matter in its simplest gaseous state is, of course, not known. To ether itself we shall devote a chapter further on, so we will not inquire now if it exists at all, but, presuming its existence, ask what relation it has to matter.

According to this theory, the entire mass of matter consists essentially of the little flaws or holes in a granular ether; so that matter is not a positive, but a negative and unsubstantial part of the universe, which, of course, has thus no substantiality left.

Others, hardly liking, perhaps, to regard matter as a minus quantity, identify it, not, as we have seen, with force, nor with holes or flaws, but with the ether itself.

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* "Science, Matter, and Immortality." By R. C. Macfie

The difference between matter and ether is reduced by Lord Kelvin to a mere difference in the size and arrangement of his ethereal vortex rings.

In discussing energy and ether we at once come upon electricity. Sir J. J. Thomson plainly declares that "all mass is mass of the ether; all momentum, momentum of the ether; all kinetic energy, kinetic energy of the ether, which to some is equivalent to electricity; matter may therefore be simply electricity in motion. When we sit on a chair we sit on whirling systems of electricity; and when the notorious Count Mattei sold his little bottles of coloured water, and called them green and blue electricity, he was nearer the truth than he suspected.

"It is, of course, only the whirling that makes electricity look like matter; once this ceases the universe disappears. But the electronic theory of matter is not yet proved; it is a beautiful hypothesis of the possible origin of matter; but even between that and a fact there is a great gulf fixed, and it does not explain certain phenomena; for positive electricity, of which the corpuscles in the atom are supposed to consist, is quite distinct from the negative electron; and what positive electricity is we do not know."

We see, then, that the third possible basis of matter is electricity. By this time it is, at any rate, clear that matter is not substantial. In spite of this, however, experience of the most varied kind shows us that we cannot produce or destroy the smallest quantity of matter; this is called the indestructibility of matter.

No one really knows more about electricity than about matter: the conception of electricity is being resolved into that of matter, and that of matter into electricity; but it is impossible to say which is the more real or unreal.

This brings us to new and startling developments; for if, as we have suggested, matter be only non-matter in motion, if it consists merely of electricity in motion, the world is surely on the brink of destruction; for who shall say that an electric discharge which is nothing more than a movement of ether is eternal?

Of course, the same force which moves the ether may move it again, and then new electrons may be formed; but the ether-ripples which constitute matter on this theory will almost certainly be converted at length into the nothingness of ethereal calm, and all theories of matter laid to rest with its final disappearance.

When we come to the relations between matter and gravitation we reach another phase of the ether problem. Why two masses of matter, when separated, possess potential energy in virtue of which they are conveniently said to attract one another, is still one of the most obscure problems in physics. The conception of gravitation as an essential property of matter, by which one portion of matter could act upon another at a distance and through a vacuum, seemed to scientists so great an absurdity that they believed no man who had a competent faculty for thinking on physical matters could ever fall into it; and this caused the invention (mark the word) of the universal ether, an unsubstantial something which is believed by many to be six hundred billion times lighter than air, by others to be hundreds of times denser than platinum! Certain philosophers, however, who imagine that they have some faculty for thinking, have believed that action through a vacuum *may* be possible; for instance, Herbert Spencer says: "Matter acts upon matter through absolutely vacant space."

Hegel's definition of matter, which was till recently taught in our universities, as translated into English by W. Wallace in "The Logic of Hegel," is as follows: "Matter is the indeterminate reflection-into-something-else or reflection-into-self at the same time as terminate It is consequently thinghood, which then and there is the substance or substratum of the thing; by this means thing finds in the matter its reflection into self." This seems quite as clear and true as much that is taught now!

Prof. Hovenden tries to comfort us by saying that matter has existed from eternity and lasts for ever, and is therefore eternal. He states that the sciences of chemistry and physics prove this to be a fact, and that if it is not a fact they would cease to exist. This seems to put these important sciences on a very insecure basis, which may not be found acceptable. Lavoisier stated that matter is not created, and does not disappear; it is therefore everlasting—another interesting but not convincing *ipse dixit.* These sayings are merely quoted to show where we are, or rather where we are not!

Lord Kelvin says that matter is that which can be perceived by the senses, or that which can be connected by, or exert force; which is safe, but not illuminating. Prof. Tait says: "We do not know, and probably are incapable of discovering, what matter is; its ultimate nature is probably beyond the range of human intelligence." This seems the wisest saying of all.

Greek philosophers could point out that matter must be either continuous or atomic; each philosopher could make deductions from each hypothesis; but it needed the inductive knowledge gained by observation of chemical combination at the beginning of the nineteenth century to bring forward overwhelming evidence in favour of the atomic theory, and establish it as scientific, though this again, alas, was to be disproved before the close of the same century; and yet another hundred years may be required before human eyes may have evidence of the existence and movements of the individual constituents of an atom.

Karl Pearson shows that matter is a group of sense-impressions, and matter in motion is a sequence of sense-impressions; the source of either, however, lies beyond sense-impressions, and is unknown and unknowable. But science does not deal with the unknowable, and mechanical science no more explains the motions of a molecule or a planet than biological science accounts for the growth of a cell. If matter be dismissed as unknowable, it is beyond the range of scientists, and we may accept the dictum of Prof. Tait quoted above.

Huxley points out that the argument which leads us to materialism inevitably carries us beyond it. "If the materialist affirms that the universe is resolvable into matter and motion, Berkeley replies: 'True, but what you call matter and motion are only known to us as forms of consciousness, and the existence of a state of consciousness apart from a thinking man is a contradiction in terms.' Therefore, if I were obliged to choose between absolute materialism and absolute idealism, I should feel compelled to accept the latter alternative."

Let the unsophisticated materialist therefore beware before he believes that he understands the universe, when he is acquainted with its material side only, through the evidence of his senses. At any rate, he is not likely to do so after reading this chapter.

I will conclude this perplexing review of the general position with a few detached remarks.

Tyndall says that of the way in which matter acts on matter we know nothing. Since radium was discovered, there is increasing evidence for the transmutation of metals. There are also other hints of the universal degradation and eventual dissipation of matter, in the behaviour of the alpha and delta rays, and other new agents that are too complicated to describe, but which seem to point to the same conclusion. Matter would also appear to be endowed in some way with an unconscious sensibility which cannot be equalled by the conscious sensibility of any living being; this is shown in wireless telegraphy, and in the response of metallic (nickel and silver) dust to Hertzian waves produced hundreds of miles away.

The material universe is one whole, and atoms of matter are the bricks of the universe out of which both we and the Milky Way are built up. Newton's great law that " every particle of matter in the universe is related to every other particle, as each of the planets is related to the other heavenly bodies," leads us to the astounding conception, with which science can find no fault, that a molecule may itself be a solar system in miniature; and, as we shall see in the next chapter, Newton's supposition is now wellnigh proved.

There is no doubt whatever that matter is the miracle of miracles, the most mystical of all things mystical, and its study the very borderland of borderlands!

It is also clear that the poet's words may be literally fulfilled any day in accordance with the speculations of modern science:

"*The cloud-capp'd towers, the gorgeous palaces,*
The solemn temples, the great globe itself,
Yea, all which it inherit, shall dissolve,
And, like this insubstantial pageant faded,
Leave not a wrack behind."

Turning for one moment, in closing, from the earth to the heavens, we find that the air has become almost as mysterious as the earth. We used to think it a mixture of oxygen and nitrogen, with a trace of carbonic acid ; but this simple analysis was upset by Ramsay's discovery of argon, and now air is found to be usually composed of nitrogen, oxygen, argon, carbon-dioxide, neon, helium, with some ammonia, oxides and krypton, xenon and hydrogen, to say nothing of extraneous bodies which may load it with impurities.

Let us, however, pass on with chastened minds to the still more trying subject of the molecular physics of matter, on which we have here only touched incidentally.

CHAPTER XXI

Atoms and Electricity

In molecular physics, which we now reach, investigation reveals worlds upon worlds of perplexing wonders of which we had not the remotest conception until our more delicate means of examination enabled us to perceive them.

There is, however, no hint that we have yet reached finality; the marvels of creation, whether in minuteness or magnitude, seem only bounded by our powers of observation, and it is not only possible, but extremely probable, that so long as these continue to be increased in micro- and macro-power we shall ever find fresh fields for wonder.

We will first of all consider atoms and molecules, and then the most interesting subject of their connection with electrons.

To keep things clear, we must understand that, in the most modern parlance, matter consists of molecules, molecules of many atoms, and atoms of corpuscles and electrons. We shall often find, however, in all but the most recent writings that the words "atoms" and "molecules" are used interchangeably. In scientific language the ultimate particles of any substance that cannot be made smaller without the character of the substance being lost are called molecules. There is, therefore, an essential difference between the physicist's molecule and the chemist's atom, the former being a particle of indefinite size that is capable of free and independent movement.*

Prout and Lockyer believed that primordial atoms were all of the same pattern. Clerk Maxwell points out that " each molecule throughout the universe bears the stamp of a metric system as distinctly as does the metre of the archives of Paris." " No theory of evolution," he continues, " can be formed that will account for the similarity of molecules; for evolution necessarily implies continuous change, and the molecule is incapable of growth or decay, of generation or destruction. None of the processes of nature since nature began have produced the slightest difference in the properties of any molecule, therefore we are unable to ascribe their existence or their properties to any of the causes which we call natural. On the other hand, the exact similarity of each molecule to all others of the same kind gives it the essential character of a manufactured article, which precludes the idea of its being eternal and self-existent."

The word " molecule " is here used by Clerk Maxwell for " atom."

As to the size of the atom, nothing less than a cluster of a billion atoms can be seen with the strongest ordinary microscope. Curiously enough, all recent research seems to suggest that objects in nature increase in importance as they diminish in size.

The late Lord Salisbury, in his Presidential address to the British Association (previous to the discovery of radium), asked whether the atom of each element is a movement, or a thing, or a vortex, or a point having inertia; whether there is any limit to its divisibility, and, if so, how that limit is imposed; whether the long list of elements is fixed, or whether any of them have any common origin. But practically all his questions still remain unanswered, and the whole subject, even in the light of radium, is still obscure.

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* Avogadro's law, which implies that all molecules of gases are of the same size, or at any rate occupy the same space, must not be forgotten.

The knowledge of the physiology of molecules is entirely in a borderland condition.

The spectroscope enables us to detect in a thimbleful of air one particle out of four millions ; but though the particles are so minute, each one of them contains about ten million million atoms in incessant movement.

These are revealed to our sight for the first time in the history of science by the ultra-microscope, through which a particle of colloid gold resembles nothing so much as myriads of dancing gnats in a sunbeam crossing and recrossing in all directions with inconceivable rapidity. Surely, inasmuch as they have ever done so, and apparently ever will do so, we have here something very like true perpetual motion.

Atoms in molecules do not absolutely touch. Thus, a bullet magnified is not a continuous solid mass, but resembles a circular swarm of bees moving with inconceivable rapidity around each other but never coming in contact. Molecular theories of the old school of physics, however, teach us that the molecules of crystals are in actual contact ; but to-day this is questioned by many.

All this has to be taken into account when we want to form any theory of the ultimate constitution of matter.

Modern science, with its incessantly moving world of atomic molecules, each one in its appointed orbit, and all co-operating in the production of the forms of matter with which we are familiar, organic and inorganic, affords irrefutable proof of design, and one of such an inconceivably intricate nature that probably no finite mind will ever grasp it.

Sir William Crookes states that "if a tiny hole were perforated by an electric discharge in the glass wall of a vacuum bulb, and air entered through this hole at the rate of a hundred million molecules (or atoms) of ordinary size per second from the birth of the solar system, the little bulb would not be filled with air in the course of four million centuries; and yet this bulb can be filled with air in two hours, the size of the molecule being capable of diminishing almost infinitely, so that they can enter the bulb at the rate of three hundred trillions per second." To this we must add that science generally considers that the theory of compressible and expansible atoms is not yet proved. In fact, the whole atomic theory has not yet advanced to the dignity of a scientific truth, and opinion is still divided on the subject.

"It cannot be pretended that we have at present any but the most rudimentary theory of the atom," says Dr. N. R. Campbell in his "Modern Electric Theory"—the latest dictum on the subject. He adds: "None of the suggestions that have been made as to its structure lead in any case to the possibility of calculating in detail one property of an atom from a knowledge of the others; no quantitative relations can be deduced; and until such calculation is possible, all the hypotheses must be regarded as vague and tentative."

Larmor says that the material molecule is formed of ether, and of nothing else; while Dr. Whetham says that matter is a persistent form flitting through a universal sea of ether.

Any advance in the study of atoms at the close of the nineteenth century has been really due to the study of electrified instead of unelectrified atoms. The difference is most remarkable. We have no means sufficiently sensitive to detect the presence of a million millions of unelectrified atoms, whereas it is believed that a single electrified atom can in some cases be detected.

But in electricity we reach another borderland in the simple question, What is it? Whether or not electricity is a fluid is most doubtful, for the term fluid is chiefly applicable only to a substance, and electricity is considered by many scientists to be a mode of motion, and not a substance at all.*

Prof. Duncan points out that we are entitled to believe, "*if we like*," that the whole mass of the corpuscle arises from its electric charge; but we deem the corpuscle to be the main constituent of an atom which is itself a constituent of a molecule, and a molecule is a constituent of a mass of matter such as a table or a chair. Hence, on this view, the inertia of any material body, or the mass of it measured by the inertia, is due simply to electric charges in motion.

Some conceive an atom to be an aggregation of negative corpuscles arranged in a certain way, surrounded by a sphere of positive electricity which balances the negative electricity of the electrons within it.

But this does not tell us what positive electricity is. If it is made up of particles, then such particles must either have no mass at all or very little, for the mass of the atom seems to be simply the sum of the masses of its negative corpuscles. Positive electricity as apart from an atom does not seem to exist; its nature is to-day a mystery.

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* The word electricity comes from *elektron*, the Greek word for amber, that being the first body that was observed to be capable of electrical excitation by rubbing.

Why matter should be more associated with positive electricity than with negative is another borderland question of which we have as yet no solution whatever.

No doubt modern knowledge has greatly increased the validity of the atomic theory, but it has shown us that these atoms are not actually ultimate in their nature, and we can have no valid notion of the inner nature of the atom until we solve the nature of positive electricity, about which practically nothing is known.

The atom now is believed to consist of two parts, a larger and a smaller, the smaller electrified negatively and the larger positively; the smaller part consisting of particles called electrons, which are believed to be individual corpuscles of negative electricity. These electrons are not fixed, but move with great velocity in definite orbits; they repel one another, and are constantly endeavouring to fly away from the atom, but are held in attraction by the mass of positive electricity. If the atom be broken up, some of the electrons fly away to join some other atom. This raises the question of gravitation; but if we ask what is gravitation, the answer, as we have seen, is not forthcoming, for we have not even glimpses of an idea of the physical basis of the nature of this force.

Atoms of negative electricity can be isolated from atoms of matter, but so far it has been impossible to isolate atoms of positive electricity.

The word electron was suggested by Dr. Johnstone Stoney, who, I believe, discovered the electron. There is only one kind of electron, which is found as a constituent of every kind of atom and every variety of matter. Its mass is said to be one-thousandth part of that of an atom of hydrogen.

Sir William Ramsay says: "The number of electrons in an atom is roughly in proportion to its atomic weight, and is about one-half; and thus in the carbon atom (12) there will be six electrons, in the oxygen atom (16) eight, and so on; there is, however, room in one atom of hydrogen for 1,700 of these electrons." *

In good conductors electrons move from atom to atom without much hindrance, while in non-conductors their movements are so hampered as to be almost impossible. The electron is at present better known than the atom, and it is likely that an electron theory of a chemical atom will also be established. The well-marked physical and chemical properties of atoms are now attributed to the electrons, i.e. to action.

Sir Oliver Lodge says: "An electron is only a peculiarity or singularity of some kind in the ether, which is of perfectly uniform density everywhere."

Prof. Sir E. Rutherford, writing on this subject, says: "Although it is very difficult to obtain direct evidence, I am personally inclined to believe that all atoms are built up of positive electrons, hydrogen nuclei, and negative electrons, and that atoms are purely electrical structures."

So far only a beginning has been made in the attack on the detailed structure of atoms, that fundamental problem which forms the basis of physics and chemistry By comparing theory with experiments, it is found that the mass of the electron is electric in origin, and that there is no necessity to assume that the charge is distributed over a material nucleus. We thus arrive at the remarkable conclusion that the negative electrons are not matter at all in the ordinary sense, but probably

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* It has been stated that hydrogen contains no electrons; this, however, is not supported by scientists generally, who estimate the number from 4 to 1,000 (Lodge).

unembodied electrical charges, whose motion confers on them the properties of ordinary mass.

Dr. Whetham writes: "The whole of the observed mass of the corpuscle is an effect due to the electromagnetic inertia of its electric charges." He represents the atoms of ordinary matter as made up of corpuscles, and identifies the corpuscles with the electron or isolated electric charge units, and so explains their mass, like Sir E. Rutherford, by the electro-magnetic properties of a moving charge.

Parallels have already been traced between these atomic phenomena and cell life. The contrast between the large and heavy parts of the atom and the minute electrons recalls that between forms of organic life where the female individual is larger and less mobile than the male. The attraction between the two sexes is parallel to that between positive and negative electricity, and both attractions produce the most momentous results in their respective worlds.

Chemistry may thus eventually split up into physics and biology. The atoms of elements only differ in the number and arrangement of the electrons they contain, the corpuscles being nothing but unembodied electrical charges. It is, however, by no means yet certain that the electron can really be reasonably regarded as one of the primordial particles of matter out of which all atoms are built up.

Prof. Sir J. J. Thomson discovered corpuscles with masses smaller than those of any known atoms. One of these corpuscles represents units of negative electricity.

An atom with a corpuscle in excess is an atom negatively electrified; an atom with a corpuscle less than the normal number is an atom positively electrified. These corpuscles are the hypothetical electrons of Lorentz;

such bodies or electrons possess mass, as we have seen, in virtue of their electro-magnetic qualities. So far the results of all experiments point to both the charges and mass of the positive electrons being different from those of the negative. But as regards the whole subject, we may say that as hydrogen and oxygen are not identical with water, but are products of its disruption, so electrons and electricity may not really be identical with matter or mass, but products of its disruption.

Lines in the spectrum of any gas are caused by the revolutions of its electrons about a hundred times in one-six-thousand-millionth of a second, and a current of electricity is now believed by some to be nothing more than a stream of electrons set in motion by electromotive force, of which positive electricity possesses an excess.

These electrons are said to move with such speed that in the atom they change their places forty million times a second; they are also extremely light, but at present the question as to why the smallest possible atom—that of hydrogen—is more than a thousand times heavier than the negative electron of matter is absolutely unanswerable.

It is quite possible that much light on molecular physics might be gained by a consideration of astronomical phenomena happening on a larger scale. Prof. J. P. Cooke says: "A theory that assumes that within the masses of material bodies the motions of suns and solar systems are reproduced on a scale so minute as to tax our powers of imagination to grasp is in complete accordance with all the facts that have been observed.

"The central masses of atoms are surrounded by electrons in some such way as our sun by planets; the ratio and scale and space and time in the motions and qualities of the electrons and central mass are those of our own solar system; to enlarge the one to the size of the other, the atomic 'solar system' must be multiplied by 10^{22}. Similarly, if the whole of the solar system be divided by 10^{22}, it is reduced to the scale of an atom. Neptune, therefore, may be likened to a detachable electron, for it bears about the same ratio to the solar system as an electron does to the atom; the whole solar system, indeed, would produce a spectrum very similar to the spectrum of a chemical element."

If, on the other hand, we enlarge the atom by multiplying it by 10^{22}, which would make it the size of the solar system, its two detachable electrons would closely resemble Uranus and Neptune.

We have spoken a great deal about electrons, but we must not forget that they have not yet advanced to the dignity of scientific facts. Skilled scientists tell us that the rock ahead of any electron theory is crystallography. The electron theory, as I have just said, has given us a concept of an atom as a sort of solar system in miniature; crystallography, on the other hand, brings us face to face with the solid reality of particles still considered by many scientists to be in absolute contact, forming structures of marvellous regularity, with all the characteristics of a true architecture of solid brick. And yet even as I write this I have an inward suspicion that these ideas of the structure of crystals, which are already doubted, may shortly undergo a further radical change.

The reader, I am sure, has long felt with regard to this and other statements, so many of which are made to-day only to be disproved to-morrow, that the amount of faith required is such as we are accustomed to associate with religion rather than with science.

So far, I think, we may assert, without any fear of contradiction, that to say the subject we have glanced at is in the twilight of borderland is, if anything, to overstate rather than understate its position. Certainly, until recently it was all in the black darkness of the unknown.

CHAPTER XXII

Force and Energy

FORCE and energy are much the same thing; but the former is potential, and the latter probably all kinetic, though scientists do speak of "potential energy."

To modern workers electricity and force are inseparable. Dr. N. R. Campbell, one of the most advanced of our electricians, in his "Modern Electrical Theory," says: "Electricity at rest is electro-statics; all electricity in motion is electro-magnetism. The force that moves this world may be called electro-static attraction, which may also be called the gravity of the infra-world.

"If we accept the view, which is really fundamental in modern electrical theory, that 'all forces acting on all material bodies are essentially electro-magnetic,' we reach the conclusion that the mass of a system varies with its electrical energy; and since this proposition is inconsistent with Newtonian dynamics, which states that the mass of a body is a constant property, the acceptance of it makes it necessary to revise the entire body of our dynamical principles.

"There is not the smallest prospect of our being able to subject any of these conclusions to the test of experimental verification, for in order to do so we should have to be able to make accurate observations on bodies moving relatively to us with velocities approaching that of light."

Magnetic forces are due to the steady motion of electrons through the ether; there is no such thing as magnetic fluid or a magnetic pole; indeed, magnetism as an entity entirely disappears, being now resolved into the motion of electrons. Thus passes a conception which has given rise to more misunderstandings and false speculations than perhaps any other in the history of science.

The view of the atomic character of electricity, which is at length coming into the scope of direct experiment, has been increasing in precision ever since it arose, and yet as a force electricity is still in its infancy. It is quite possible we shall soon find that the decomposition of water will provide the simplest substitute for coal. Our ideas of the nature of combustion have been entirely altered by the discovery of electric force; and yet, in despite of this, the actual nature of electricity itself remains an enigma. Then with regard to increased speed of transit, this new force promises much. We may note that Mr. Bachelet's electric train already runs at 300 miles an hour.

The danger of a theory is that it suggests more than it asserts. The statement that electricity is a fluid, for instance, simply means that it can move with great ease through some bodies, but does not mean that it has definite weight or volume, or will evaporate when heated.

The sun's heat is an immense source of force to the world; its average temperature is estimated to be about 5,000 degrees Centigrade. No one knows the source of it, though radium transformations now largely replace the theory of meteoric bombardment. The mere fragment of solar rays that impinges upon this earth is said to be equal in one year to more than two hundred and seventeen billions of horse-power.

No word in science is more frequently used than "force," but we cannot attribute to the term any distinct significance. We have as yet absolutely no proof that force in itself has objective existence; in all probability there is no such thing as force, any more than there are such things as sound or light, which are mere names for impressions made on the senses. As Tyndall says: "We know no more of the origin of force than of the origin of matter; where matter is, force is; for we only know matter through its force."

No constant meaning attaches to this "force," and we are involved in hopeless confusion in the use of the word.

Alfred Russel Wallace says: "Matter is essentially force, and nothing but force; force is will, and nothing but will, and that the will of one Supreme Intelligence." Force is persistent, and never dies; God does not die, "He is the same yesterday, to-day, and for ever."

In the "correlation of force," the theory established by Sir William Grove, we have a very sound expression. The idea is that all the great forces we know in nature are so related to each other that from one we can always produce all the rest. Thus, mechanical motions in matter produce light and heat; these again produce chemical affinity; these electricity; while electricity can be made to reproduce heat, light, chemical affinity, and mechanical motion.

There is nothing else but force underlying phenomena; phenomena are the correlatives of force, and force is all.

Tyndall speaks of the identity of light and heat; but correlation is not identity.

The modern use of the word energy, like that of force, is vague and often misleading. Energy, as we have said, may be kinetic or potential, and the sum of these two is believed to be everywhere constant. This is the meaning of the conservation of energy. But Prof. Thrift says: "What we call potential energy may be energy stored in the ether; and if it exists there as the motion of the ether, then we may regard all energy as kinetic."

The doctrine of the conservation of energy was established about the time that marked the rise of electrical science; but Dr. McCann declares that "the conservation of energy is but a bundle of vague assumptions."

The conclusion has been reached by some that modern science, by its discovery of the doctrine of the conservation of force, has no occasion to believe in design, or in God. On the other hand, the Introduction to Herbert Spencer's "First Principles" professes to prove that while modern science finds reason to believe that there is an Absolute, it finds equal reason for denying that this Absolute can ever be known.

It is indeed doubtful whether the conservation of energy is true of vital forces. From the two doctrines of the conservation and dissipation of energy,* it is deducible that the duration of the earth as a living planet must be strictly limited in time. It must have had a beginning, and at the beginning was furnished with a store of energy which it has been dissipating ever since; in this spending of energy its life consists, and when the store is exhausted its life will cease and the bankrupt earth will become numbered amongst the dead planets.

All things, indeed, tend to static equilibrium, which means death. Energy is solely of use to us because it is constantly being transformed; but the possibility of transformation grows less and less, and thus, though the quality of energy remains for ever unchanged, its availability for use decreases. Sir Oliver Lodge has, however, recently shown that dissipated energy is not energy proper, and that in this sense the law must be questioned. The general facts, however, are not disputed, that the final tendency is to static equilibrium, which is the main point. The rest is merely a question of terms.

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* The law of the dissipation of energy was first formulated by Lord Kelvin as a result of his profound studies in thermo-dynamics.

Neither energy nor matter can be created or destroyed by any machine or process at the disposal of man. Romanes makes the profound remark that "all energy is will energy, and *all objective causality really subjective.*"

Energy is seen everywhere, for so far nothing in nature seems too small to have parts incessantly active in themselves. Heracles said: "All things are in motion," and this is now proved to be true for the first time. Karl Pearson asks, "What is it that moves?" and replies, "We do not know." "Why does it move?" "We do not know." "How does it move?" "We do not know."

The doctrine of "persistence of energy" was the work of many scientists about 1850. The atomic and molecular theory was somewhat earlier; while the idea of electrons is quite modern.

The "transmutation of energy" is a misleading term because it is unjustified by anything that is really known; it does not follow that because one force can be made to produce the action of another the two are identical, or that both are nothing but varieties of one power which we call energy. Energy and force are thus seen to be the expression of an almighty mind, and so once more we are brought face to face with the beginning and end of all, the One who is all and in all.

CHAPTER XXIII

Gravitation, Time, and Space

Nothing can really be decided about gravitation until the question of ether is settled. A short time ago we seemed to know nearly all about both, but now we are not quite sure what we really know about either.

Prof. Marmol, writing in 1909, said: "It is almost universally admitted that gravitation is ultimately the prime source of every energy." It is certainly the fundamental cause of motion, and its laws are scientifically asserted (perhaps prematurely) to be unchangeable, eternal, and necessary. Gravitation has quite recently been defined as ether pressure.

Newton declared with rare humility that heavenly bodies act as if they attracted one another; but whether they do so in reality, and how, was beyond his comprehension. It is believed that no one to-day has any more real scientific knowledge of gravitation than Newton had.

Karl Pearson points out that the law of gravitation is not so much the discovery by Newton of a rule guiding the motion of planets as the invention by him of a method of briefly describing planetary motion.

In considering this difficult subject it is of great importance to distinguish between cause and effect. The force of gravity is said to vary inversely as the square of the distance, because the planets are found to move in ellipses with the sun in the focus; but people will often substitute the effect for the cause and say that planets move in ellipses because gravity varies inversely as the square of the distance—which is not true at all.

Lord Kelvin considered ether outside the law of universal gravitation, being absolutely imponderable. This view we will further examine in the next chapter.

Maurice Maeterlinck says: "It is not absurd to hope that some day we shall lay hold of that essential secret of the world which for the time being we have called the law of gravitation, though eminent philosophers persist in regarding the great riddle as unknowable, and its anomalies and variabilities as inexplicable."

An interesting problem in gravitation is presented by the flight of a golf-ball, inasmuch as it often greatly exceeds in distance the length which theoretically the force of the drive gives it. The solution of this anomaly occupied Prof. Tait for some years, and he found at last that the additional length was due to the under-spin of the ball. On the other hand, over-spin or topping the ball brings it to the ground sooner than it ought to fall. Amid so much twilight it is delightful to note that here we get a successful attack on a borderland question, with the happy result of bringing the problem into the range of scientific fact.

But why a stone or a golf-ball falls to the ground at all, is still just as mysterious to us as are the motions of the sun to a barbarian. The law of gravitation may describe how bodies fall, but it does not tell us why; and we do not even yet know whether gravitation is a push or a pull.

The laws of gravitation are so intimately connected with the concepts of time and space, and, indeed, so depend on the hypothesis of their existence, that we cannot do better than conclude this chapter with a few brief remarks upon them as a part of the borderland territory.

Time and space may not constitute sciences, but they are certainly scientific concepts, and inseparable from science. Few, perhaps no scientific studies can be pursued without them, and apart from science no two subjects could possibly seem to us more absolutely established as facts, beyond any doubt or dispute, than time and space; but science, I much fear, nowadays actually insists on their being placed in the borderland.

In "The Grammar of Science" Karl Pearson says: "Space and time are not realities of the phenomenal world, but the modes under which we see things apart; they are not infinitely large nor infinitely divisible, but are essentially limited by the contents of our perception." If space be termed the breadth, time may be termed the length of the field of perception; both are only known to consciousness.

Nevertheless, time is an absolute necessity and a fundamental form of our conceptions of knowledge; but any limits to time are as inconceivable to us as their absence. And this is also true of space. In other words, our minds are so made that we cannot conceive time and space to be either finite or infinite.

Bergson, however, actually says, with considerable hardihood, that "time is the stuff of which psychical life, and indeed the ego, is made; and there is no stuff more resistant or more substantial [!]. Time is a concrete and not an abstract quality; its duration is the very stuff of reality. The body is in time and space, the mind is in time only." Whether our personality is in space or not depends, of course, upon whether we deem it material, for we say matter has mass, and mass has extension, whereas spirit has neither.

Karl Pearson, again, points out, in the work just quoted from, that only for us, as perceiving human beings, has space any meaning at all, and that we must distinguish between perception and conception, for a mathematical point is a concept, but never a percept ; what is imperceptible is not therefore inconceivable. He proceeds : " The space of our perceptions . . . is not infinite, it is exactly commensurate with . . . our perceptive faculty. . . . The only infinite space we know of, so far from being a real immensity, is a product of our reasoning faculty. On the other hand, cosmical space, the mode of our perception, is finite and limited by the range . . . of what we actually perceive to coexist." There is thus the finite space of perception, and the infinite space of conception, and both lie within the human consciousness. This, of course, contradicts what I have stated above. It is for the reader to decide which is true. The whole subject can be regarded from so many points of view that I think he will be wisest if he says, " Both."

Stanley Jevons, in " The Principles of Science," says : " True science will not deny the existence of things because they cannot be weighed and measured ; it would rather lead us to believe that the wonders of possible existence surpass all that our mental powers allow us clearly to perceive. The study of logical and mathematical forms has convinced me that even space itself is no requisite condition of conceivable existence. Everything, we are told by naturalists, must be here or there, nearer or further, before or after. I deny this, and point to logical relations as my proof. . . . So far am I from accepting Kant's doctrine that space is a necessary form of thought, I regard it as an accident and an impediment to pure logical reasoning. Material existence must exist in space, no doubt; but intellectual existences may be neither in space nor out of space; they may have no relation to space at all, just as space itself has no relation to time. For all that I can see, there may be even intellectual existences to which both time and space are nullities." Here is another disagreement—abundant proof that our present subject is in the twilight.

To my own unscientific self it seems that to the conditioned and the relative, i.e. to humanity, time and space are ever necessities of thought, and only to the absolute and unconditioned are they non-existent.

CHAPTER XXIV

Ether

THERE is no such striking instance of a substance (which, by the way, it is not) that is purely hypothetical being universally accepted as equivalent to a proved entity, though confessedly but a mental concept, as that of ether.*

The very premise which forced this concept, that " action at a distance is impossible," is questioned by many scientists and philosophers to-day.

When Carlyle was asked to assent to the truth that a body cannot act where it is not, he answered : " With all my heart. But, pray, where is it ? " It may be quite well argued that a body is where it acts.

The Duke of Argyll, the author of " The Reign of Law," wrote : " Sir Isaac Newton declares that it is impossible for any instructed mind to conceive of action at a distance, that is to say, that one body can exert any action over another except through some intervening medium ; but Newton's dictum about action at a distance, that is, through empty space devoid of any matter or medium, has wide results, for how far can we presume that things which are inconceivable to us are therefore impossible in nature ? Do we not remember that to our ancestors the idea of the antipodes was inconceivable, but that now no child has any difficulty in conceiving it ? In what did the inconceivable consist? It consisted in the impossibility of imagining a place where men stand with their heads downwards. In this our fathers were not wrong, but quite right; but what they did not know was that the words 'downwards' and 'upwards' had no meaning except in regard to the law of gravitation; there is no such thing as downwards and upwards in free space. Newton, with his denial of action at a distance, may create a difficulty which may disappear. What is distance? What is action? There may be a whole world of misconceptions hidden under these familiar words. The only instrument we possess for the acquisition of any truth is the trustworthiness of the human intellect, when it is exercised and sufficiently informed; we have nothing else to work with and nothing else on which to rely."

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* The hypothesis of ether was probably made in England, in the Royal Institution.

Ether is said to have been invented to escape the breaking down of the laws of general mechanics, which, no doubt, is true; the question is, Are these laws universal and true under all conditions? Is action at a distance possible? What about the force that incessantly moves the planets in space, of the corpuscles in atoms and the atoms in molecules, that never touch? Is this universal force transmitted through ether?

Ether seems at once everything and nothing. It is supposed to be so pervasive that it fills infinitude, and yet so evasive that the late Lord Salisbury once said it was nothing more than the nominative case of the verb "to undulate." Ether is really more comprehensive than the Deity as the primary seat of all force. To ether science must superadd energy in the form of heat, light, chemical force, electricity, etc., all of which forces are regulated by law. Prof. Mendeléeff (1902) says: "Ether makes us lose all sense of reality, and wakens the misgivings of the earnest investigator directly he realises that it must permeate all substance."

Several ethers have been postulated by different philosophers for different purposes, but the only ether that has survived is that conceived by Huyghens to account for the propagation of light. All solid ground seems to disappear from beneath our feet when electrons and corpuscles, the ultimate basis of matter as now believed, are themselves said to be nothing but centres of elastic strain in a hypothetical ether.

Ether is still a concept, but not a percept, for even Hertz's experiments do not seem to have logically demonstrated the perceptual existence of ether; it is still only known to the eye of the mind; its origin, its nature, and indeed its very being, are still shrouded in impenetrable darkness.

The theory of an all-pervading ether was implicitly revived by Thomas Young (1773–1829), who re-established the wave theory of light; for if light be waves, something that undulates must subsist through space. Still, many scientists now feel that the attempt to investigate ether may have to be abandoned, and that, it may be, we have gone too far in imagining an all-pervading stagnant medium, with the mechanical properties suggested to our minds by the words "universal ether."

There is no doubt that in many ways this all-sufficing invention of the nineteenth century of science has sustained rude shocks by recent discoveries. It may recover, and the universal stagnant ether once more hypothetically surround us; or, on the other hand, ideas may have to be rebuilt on entirely new lines, and this dubious "fluid" pass into the great museum of intellectual antiquities.

Many materialists who wished to be specially up to date began at one period to call themselves etherealists; whether they were wise or not, time will show.

The properties of this ether, as well as its existence, are, of course, wholly inferential. It was first conceived as a fluid; but it is certainly not a liquid, nor a solid, nor a gas, nor radiant matter. Supposititious ethers of contradictory qualities have fast followed one another, and space has become filled with their turbulent motion, vortex filaments, and solid, densely packed spheres (of the imagination).

Still, there are those who regard ether as within the range of scientific fact, and Mendeléeff speaks of it (though, as we have seen, denying its supposed quality) as undoubtedly real. He concludes that it is an inert gas one million times lighter than hydrogen. Others have regarded it as elastic jelly, others as fibrous like a bundle of hay, others as grains piled like cannon balls. It was Prof. Larmor who considered it a mass of endless vortex filaments something like wire entanglements. Clerk Maxwell, in the "Encyclopædia Britannica," defines it as "a material substance of a more subtle kind than visible bodies; supposed to exist in those parts of space which are apparently empty. Whatever difficulties we may have in forming a consistent idea of the constitution of ether, there can be no doubt that the interplanetary and interstellar spaces are not empty, but occupied by a material substance or body which is the largest and most uniform body of which we have any knowledge."

But there is a further possibility in ether. We know that matter has some psychical significance, since it can constitute brain, which links together the physical and psychical worlds. If anyone affirms that ether, with all its massiveness and energy, has none, he probably goes too far.

Prof. Reynolds makes ether 480 times denser than platinum, and he compares matter to bubbles in this dense medium. As we have said, it was first of all infinitely more tenuous than gas ; it then came to resemble a jelly rather than air ; and now it is found to be a substance hundreds and thousands of times denser than steel ! Sir Oliver Lodge considers ether millions of times denser than iron, and indeed so dense that all matter by comparison with it is like an imperceptible mist.

If ether be, as our latest scientists declare, an imponderable solid, then the word " firmament " in the first chapter of Genesis, which means a solid and probably metallic structure, and which has caused great amusement to our higher critics, may, after all, be the best scientific description of the vault above us.

There are still further surprises, for indeed the story of ether runs the tales of Hans Christian Andersen very hard. For instance, the smaller waves of light in ether, according to Sir Oliver Lodge, must " vibrate 5,900,000,000,000,000 times in a second, or far more times in a second than there are letters in all the books of the British Museum Library. Any medium that can do this must be extraordinarily elastic and dense, and all matter by comparison be like gossamer." Such a concept appears to transcend the wildest stretch of our imaginations ; and when the same author proceeds to state that " the intrinsic energy of this ether is so great that every cubic millimetre of space possesses energy equal to the output of a million horse-power for forty million years," we are not inclined to contradict him. After this we can well believe that matter is only a small consideration in this marvellous medium, which may even constitute the organisms of unknown beings higher than ourselves.

We are told that when a steel spring is bent, what it is that is strained is not the atoms, which are only displaced, but the connecting links of the atoms—the ether—so that the distortion of the spring is really the distortion of the ether, all stress existing there; for matter can never be moved directly.

It is doubtful if one piece of matter ever has touched another piece of matter; for the atoms are connected by ether, and matter can only act on matter through ether. When no one doubted the fact of ether, attempts were made to express matter in terms of ether. Lord Kelvin's idea was that all the vortex rings in a fluid were ether. Karl Pearson regarded matter as ether moving backwards and forwards between three dimensions and four. Larmor's idea was that an electron was a stray knot in the ether. All these are attempts to bring unity into physical science by identifying matter and ether.

I hope my readers are not tired of ether. Just one or two points more—and, after all, the repetition of facts and figures we cannot grasp is often very soothing to the mind!

A recent supposition is that ether consists of primary matter, out of which chemical atoms are formed. The corpuscles of the atom have been proved to be nothing but electricity, just as light and heat are nothing but waves of ether, and ether is nothing save force.

It is really no more solid than a symbol, no heavier than an hypothesis or a nightmare; we may of course assume it is a something, but this something is immaterial. It is also imponderable, and yet more rigid and dense than steel; but though much more rigid than steel, planets and suns pass rapidly through it without friction. We cannot weigh ether; we cannot see it, we cannot really conceive it, and none of our senses can perceive it. Ether as immaterial energy may seem inconceivable, but nevertheless it is stated to be a scientific fact.

Matter itself, however, is also only an idea, and has no existence apart from the thinking mind; it is nothing apart from force, and changes in all its characters as the force changes its form. Moreover, once the equilibrium of the electric ether of the world which makes the atom is destroyed, it can never be restored; and the ultimate ripples of ether will as surely die away as the waves which are formed in water when a stone is thrown into it, and the universe will then vanish as a dream.

In this world of illusions we may note, in passing, that as there is no motion conceivable without time and space, it follows that if these be illusions there is no such thing as motion at all.

One of the chief functions of this ether is to convey energy from the sun for the support of physical life. If you hold your hand over the fire, or put your face in the sunshine, you are conscious of something arriving on it not by ordinary matter at all, and you are now as perfectly conscious as you can be of the ethereal medium, through something akin to vibrations in the ether that the skin and eyes feel; unless, indeed, it be from the impact of molecules, of which, according to another theory, light and heat are composed.

Sir Oliver Lodge has carried out a series of delicate experiments to see if a whirling mass of iron could to the smallest extent grip the ether and carry it round with so much as one-thousandth part of its own velocity, but he could not find a trace of mechanical connection between matter and ether of the kind known as viscosity or friction.

Although the whole question is so nebulous and contradictory, science continues sagely to discuss whether ether is continuous or discontinuous, attractive or self-repulsive, and what is its relation to common matter. Scientists have found a great deal of difficulty in making ether do all that it is supposed to do, without endowing it with contradictory properties.

It is at present a working hypothesis of great value, while to some it seems to have rather more real existence than matter itself. It is supposed that without it not only should we be in a dead, dark world, but there would be no world at all. All experiments appear to show, though they do not prove, that ether is stagnant in respect of the earth, although the earth is moving rapidly through space.

The theory which, we are told, promises most favourably at present is expounded in Prof. Thrift's "Theory of Light" (1912). He proposes to regard ether as a turbulent fluid. What such a view can promise or perform is to us very cryptic.

Dr. Winslow, however, will have nothing to do with ether at all. In "Force and Nature" he says: "There was probably never a greater error introduced into physical science than the ethereal theory, and its influence in retarding solid progress has been greater than at first appears. All opinions upon the conditions of infinite space are the merest hypothesis."

With this we leave the subject in the unsatisfactory condition, as all must confess, of the vaguest borderland twilight—indeed, of chaos.

Perhaps some may think these chapters are inconclusive—which is true; but they are meant to be so

It would ill become the writer to give his own judgment on subjects he has not studied ; all that he attempts to do—and it is sufficient for the purpose of this book—is to record the views of various scientists as to the conditions of their own sciences, and show where they consider that scientific light ends and the twilight of borderland begins.

CHAPTER XXV

Chemical Physics, Light, and Radium

IT seems the height of presumption for one who knows little or nothing of the vast and growing science of chemistry to speak of it at all. I shall, however, make no attempt to enter upon its general consideration, but shall merely point out briefly a few of the more superficial of its problems that strike an outsider as being in the twilight of borderland.

Chemical substances were generally divided into solid and fluid; but the famous Dutch philosopher, Van Helmont, in the early part of the seventeenth century, invented the word "gas"; with the result that thenceforth fluids were subdivided into two species, liquid and gaseous.*

Now, the ultimate reasons of the changes between solid, liquid, and gas are not yet clearly understood, and are, at any rate partly, in the borderland.

The outstanding problem, however, that awaits solution in this science is the nature of the chemist's atom. It may be that the atoms of chemical elements are built up of primordial atoms. Prout suggested that hydrogen might be the primordial substance; but the electron, for the moment, holds the field.

Another puzzle is what is called chemical affinity. The apparent power of choice, the devoted union of some chemical couples, the fickle indifference of others, are amazing. All this constitutes an inorganic likeness of a striking nature to much that is familiar to us in the conduct of human life. Chemical affinity has never been really fathomed, and of what its so-called "bonds" actually consist, or what constitutes either molecular or chemical attraction, is quite obscure.

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* It is worth noting that in the first two chapters of Genesis all matter is divided into solid and fluid. Later on we find that the air above (gas) is distinguished from the water beneath.

Dr. N. R. Campbell, in his recently published work, is emphatic that the meaning of the "bonds" of ordinary chemical notation is not yet known to science.

All this is, therefore, in the borderland. The peculiar activity of elementary atoms in the "nascent" condition, at the moment of their release from combination, is clearly also a borderland question.

The recently discovered but most imperfectly understood transmutation of metals, and the action of the actinic, chemical, or ultra-violet rays of the sun in photography, may also be cited as obscure borderland questions.

The discovery of radium, and particularly the results of radium emanations in water, have brought the transmutation of metals for the first time within the range of true science; and the way is now opening for an exhaustive research into this ancient mystery. I shall return to this subject later (p. 217).

An almost forgotten word in science is "phlogiston." This term was invented by Stahl in 1697 to describe a hypothetical element which, combined with a body, rendered it combustible. This theory was regarded as a scientific fact for a hundred years and more, and was only displaced by the discovery of oxygen and its action in combustion.

This entire disappearance of what was once a scientific idol, and the present resurrection, in the transmutation of metals, of a doctrine once universally believed and then for a century or more scornfully denied, leads the thoughtful mind to reflect on the vicissitudes of scientific "facts," and to emphasise the truth that these are never actual verities, but at best probabilities.

One also feels that with such warnings it may be wise still to suspend one's judgment even on such popular theories as ether and electrons.

Hydrogen is a puzzle. It is regarded as the gas of a metal, and acts in all its relations as a true metal; nevertheless, when at last solidified by freezing, it appears as a white flocculent precipitate—a most effectual disguise, if indeed it be a metal at all.

This freezing of hydrogen brings us to the problem of ultimate zero, which is now fixed at – 273° Centigrade (no absolute maximum of temperature is known). This is regarded as the fixed minimum, because, as actual experiments seem to show, at this temperature all molecules touch, all molecular movement ceases, all electrical resistance disappears, and electric currents (if such were possible in these circumstances) would go on presumably for ever.

We have already pointed out that (apart from the question of temperature) the atoms in crystals have long been supposed to be in contact. Prof. Bragge has recently examined the relative positions of their atoms, but has not denied that they are very closely packed, if not in actual touch with each other.

The laws of colour in aniline and other dyes are not as yet promulgated, and many borderland questions are found in colour problems. Chromic alum in solution and gold leaf differ in colour in transmitted and in reflected lights. Some substances, e.g. mercuric iodide and zinc oxide and iodine vapour, change colour on heating.

The mystery of the persistent flame under water produced by rubbing two quartz pebbles together in the dark is an unsolved marvel, together with the peculiar smell that is produced. Akin to it is the luminosity of heated fluor spar, and the whole question of phosphorescence.

The relation of organic chemistry to life is a vexed and still unsolved borderland question.

Ferments do not rightly belong to chemistry, but I may mention here that in yeast, and indeed in ptyalin and many other ferments, we have unsolved mysteries. The conversion of sugar into alcohol and carbonic acid is very obscure, and Mitscherlich's experiments seem to show that it depends upon absolute contact being established between the sugar and the yeast globules; but Pasteur connects it with the growth of the globules.

No doubt an expert could have given many still more striking illustrations of the way in which, in this and other sciences, increasing knowledge leads always first to increasing twilight, before the unknown emerges into the full light of scientific fact.

Turning now to a brief consideration of light, we have been very proud of the discoveries of science in this direction.

The wave theory of light, with its corollary of the luminiferous ether, appeared at one time almost, nay quite, within the region of proved science. But even the wave theory of light is now challenged, in favour of the old idea of Newton that light really consists of infinitesimal particles flying through space. It was Clerk Maxwell who showed that light was to be regarded as a series of electro-magnetic waves started by minute electrical charges.

Spectrum analysis (1825) was a powerful confirmation of Huyghens' wave theory of light (1650), but in spite of this the theory does not appear to be entirely satisfactory.

The most recent view of the position is that given by Dr. N. R. Campbell, in his "Modern Electrical Theory": "The present position of the theory of light appears to be that the wave theory, supported by Somerfeldt, and the corpuscular theory of Newton, supported by Einstein, are each capable of explaining a great many facts connected with radiation, but that, in general, the facts explicable on one theory are not explicable on the other. The corpuscular theory alone can explain how the energy of radiation is transferred from one place to the other, while the wave theory alone can explain why the transference along one path is not independent of that along another. It seems as if the energy itself is transmitted by corpuscles, while the power of absorbing energy and making it perceptible to experiment is transmitted by spherical waves, but it is impossible to suggest any theory capable of explaining this distinctly. The problems of radiation are not yet solved."

Lord Kelvin says: "The slightest change in ether sends a shudder through it with inconceivable rapidity; this shudder we call radiation, one form of which is light."

Light, of course, is only light when the vibrations of which it is presumably composed are visible; if they are less rapid, the radiation becomes heat, and so radiant heat is light if we see it, it is only heat if we do not.

It may be useful to give the following table, compiled by Sir William Crookes :—

> Vibrations extending from thirty-two to thirty-six thousand per second are perceptible to us as sound.
>
> Vibrations from thirty-six thousand to a thousand millions are as yet imperceptible.
>
> Above a thousand millions they are perceived as electricity.
>
> From two thousand millions to two hundred and fifty billions they are imperceptible.
>
> From two hundred and fifty billions to a thousand billions they appear as light and colour, from infra-red to ultra-violet.
>
> From a thousand billions to two hundred and fifty thousand billions they are imperceptible.
>
> From two hundred and fifty thousand billions to five trillions they present themselves as the X-rays.

Above this again nothing is known.

In this calculation a billion is a million millions, and a trillion a million billions.

With regard to the speed at which light travels, and a hitherto unverified inference therefrom, Dr. N. R. Campbell says : " The conclusion appears that since the velocity of light varies with the gravitational potential, light travelling through a region in which that potential is not constant should not travel in a straight line. [Of course, this may be regarded as a special case of refraction.] In particular, the light from a star, if it passed near the sun on its way to the earth, should not travel in a straight line, and stars which appear to us near the sun, but are on the opposite sides of it, should seem displaced from their normal position. So far no experiments have confirmed this prediction, but should subsequent research prove them to be false, the science of electricity will be in a great difficulty.

"There is probably no physical law which is absolutely true if applied to any actual system, but the laws are none the less useful, and there are a great many systems applied to which they are very nearly true."

The cause of the alteration of wave lengths by certain chemical substances, viz. quinine, paraffin, etc., and the mystery of ultra-violet light in its disruptive chemical effect on compounds, are both at present in the borderland.

Spectrum analysis, as we are not surprised to find, has its own borderland questions on light. One is as to the ultimate cause of the dark lines which replace the bright lines in the "absorption" spectra of gaseous elements. Another is as to the reason why incandescent matter in the solid state presents a continuous spectrum, whereas in the gaseous state it gives only bright lines.

We must not go farther into these difficult subjects, with which, indeed, the writer is very little familiar. We have, however, seen that some of what was even supposed to be ascertained truth in this branch of science is now partly relegated to the borderland, and that respecting light very few incontrovertible scientific facts are known.

Radium was discovered in 1898, and the effect on the scientific world was titanic, not to say catastrophic. Some of the most solid foundations of science were destroyed, some of its noblest edifices wrecked, and scientists had to nerve themselves to face and investigate a new and incalculable form of energy. The activity of radium is believed to be due to the explosion of individual atoms, and it is calculated that thus half of any given quantity would disappear in about 1,800 years, each act of disintegration involving the explosive emission of one atom of helium, while radium itself is derived directly or indirectly from uranium.

An atom of uranium is said to disintegrate into one atom of radium, three atoms of helium, and two electrons. It is suggested by some that uranium disintegrates directly into radium; but Prof. Boltwood considers that ionium is the immediate parent of radium, and he looks on uranium as the grandparent. Uranium is half transformed into ionium in five thousand million years.

Of course, such statements are made on "scientific authority," certainly not on the author's, who cannot even conjecture how such results are arrived at.

The possession by the radium emanation of so large a store of energy suggested to Sir William Ramsay that it might be utilised to bring about chemical changes in matter, so he placed it in water. "The recorded results," says Prof. Kennedy, "have shaken science the world over," although it is well to mention that so far they have not yet been verified by other scientists. Sir William Ramsay found that the emanation of radium, instead of decaying into helium as it does when dry, decays into neon, a new gas discovered in the air; or, if there be any copper present, into argon. The radium emanation can thus become transmuted into three other elements—helium, neon, and argon, according to its surroundings. It also decomposes water, but in the resulting gas there is an excess of hydrogen. Whence this comes is still a mystery. Not only so, but it causes the decay of any copper present and produces, as a result, another element, lithium.

This transmutation by means of radium opens an entirely new scene in the drama of scientific advance; while the discovery of the simultaneous transmutation of copper into another common element is a second surprise, even more remarkable.

It is most significant to note that there is much in recent experiments in radio-activity to suggest the universal degradation of matter into its simpler forms. One dream of the mediæval alchemist has thus come true, though still we can only watch one type of matter arising from another, and even all the resources of a modern laboratory seem powerless to hasten or delay the disintegration of a single atom.

Rutherford finds that while half of any given quantity of radium would (as I have said) be transformed after 1,800 years, after 36,000 years one-tenth of the quantity would still remain unchanged.

Since radio-active minerals are doubtless very much older than this, we may conclude that a trace of radium in these minerals is maintained by some process which continuously produces this substance from some other constituent of the mineral.

Radio-activity extends to some thirty-five substances, but its presence admits of only one explanation, and that is decay; so that all radio-active substances contain transient, temporal, and dying elements.

The momentous but unanswered question is, If these elements are decaying, are not all other elements transient in some measure?

We must remember in all this that scientists are merely spectators, and are not active agents; for every process occurring in radio-active matter is spontaneous and uncontrollable, and there is no evidence to indicate that we shall be able materially to influence such changes; all that we can do is to watch them.

Consider, once more, the vast alterations of outlook in science thus produced. What, indeed, seemed more firmly established than the immutability of elements and the Newtonian dynamics; yet by the discovery of radium we have been forced to repudiate the first as a universal law, and to modify the other in order to explain the motion of bodies which nearly approach the velocity of light.

The instability of the atom was clearly shown by the discovery of radium; but the conservation of energy was not upset, for there is no ground for the popular surmise that radium emits energy without loss or waste of any kind, and that the process can go on for ever. Still, the loss of energy is enormous, for radium evolves nearly three million times as much heat as arises from any other chemical action known to man.

We close with two remarks. One, that the extinction of the unfit is a common phenomenon in the inorganic as well as in the organic world, and radium is another proof of it. The other, that we know at present enough to say that if the earth contained one-five-thousand-millionth of a gramme of radium per cubic centimetre, it would prevent it from cooling.

The subject of radium as a whole is slowly emerging out of the twilight of the last few years into the clear light of scientific fact, although its associated problems are quite unsolved, and much still remains in the borderland.

CHAPTER XXVI

Cosmogony and Geology

COSMOGONY is, as we should expect, a very speculative science, full of hypotheses and very barren of facts, and therefore mainly borderland.

Dr. James Hutton, the father of modern geology, declared that terrestrial phenomena indicated no vestige of a beginning and no trace of an end. This view is, of course, entirely exploded.

A hundred years ago nothing was known of the history of the earth, though other sciences were advancing by leaps and bounds. It was then the universal belief that the world was a recently created globe, about six thousand years old. Even fifty years ago it was taught in every school that all time with which men had to do began about 5,870 years ago.

Prof. J. J. Lobley divides the existence of this planet into three periods: the first is hypothetical, the second consequential, and the third historical; the first being the formation of the globe, the second its development, and the third the commencement of life.

Regarding the first period, Jevons, in "The Principles of Science," says: "Philosophers no doubt held that *de nihilo nihil fit;* that is to say, their senses give them no means of imagining how creation can take place. But we are on the horns of a trilemma: we must either deny that anything exists, or we must allow that it was created out of nothing at some moment of past time, or that it existed from eternity. The first alternative is absurd; the other two seem to me equally inconceivable."

Laplace's fire-mist (1796) has held the imagination of mankind until quite recently; but, unfortunately, the theory is not mechanically sound, and could not possibly work, as has been clearly shown by Miss Agnes M. Clerke.

Many others have tried to form a consistent hypothesis of the universe; but none have been entirely successful, and it is safe to say that nothing whatever is really known of cosmogony.

Laplace was so obsessed by his mechanical philosophy that when Napoleon asked him where was the place of God in his scheme of nature, he replied that he had no need of that hypothesis. We are hardly surprised to find, therefore, that his hypothesis is no longer tenable.

Prof. Chamberlain, of the University of Chicago, has evolved, with Dr. Moulton, a much better theory of the beginning of things, called the "planetismal" hypothesis. According to this, all spiral nebulæ are nascent solar systems. The beginning of our world would thus be a small mass of cold, solid fragments continually growing in size by the accretion of smaller ones round it. The central nucleus of the spiral represents the future sun of a new solar system, and the knots upon the whorls of the spiral would form the nuclei of the future planets.

This hypothesis necessitates that the planets of our system should all have been formed at the same time and be all of about the same age.

The earth, then, according to this theory, was built up by accretions of cold meteoric matter; it was never a gaseous ring, nor yet a liquid globe, but a solid nucleus subject to perpetual meteoric bombardment. Such is the most modern cosmogony: its duration none can tell.

The public has always been inclined to the teleological view of the universe, whereas science at first favoured the mechanistic and material view. Bergson's philosophy reproduces both views, and invents a vital impulse of force which derives everything that exists from the development of life, but not to any specific end, or with any specific purpose, though the impetus was psychical. His followers have abandoned theology on the one hand and scientific methods on the other in favour of this new hypothesis, which, however, does not seem likely to spread much farther.

Physics showed not only that the earth is mortal, but that its span of life of only a few million years, compared with the unlimited periods which geology had asked for it, is proved.

Prof. Tait asserts that the absurd claims of the geologist and biologist on time are in irreconcilable conflict with the demands of physics.

But no reliable estimate can really be made by science either of the age of the earth or of its duration. Generally, the beginning of organic life is dated as forty million years ago. The latest estimates of the present age of the various rocks, based on the amount of helium (a product of radium) contained in minerals, are as follows:

3	million	years	for green sand.
6	,,	,,	for basalt.
54	,,	,,	for Norwegian rocks.
286	,,	,,	for Ceylon rocks.
320	,,	,,	for blue earth (as at Camberley).

600 million years for the rocks at Ontario.
1,300 ,, ,, for some Swedish rock masses.
1,600 ,, ,, for some rock formations near Colombo.

Calculations based upon other data reach two thousand million years.

The present scientific answer, therefore, as to the actual age of the earth is between one and two thousand million years; the whole duration of life upon the earth being but the merest fragment of this period. The latest calculation of the future duration of life is but six million years more. It is only right to add that these figures are not only staggering, but probably very incorrect; and that the whole subject is a borderland question.

We now turn to geology, which is the youngest of all the sciences. Its pioneer in England, in 1815, was William Smith, who soon found that Hutton was wrong when he said that geology gave us no trace of a beginning and no symptom of an end of the world, for it does give us distinct traces of a beginning and many symptoms of an end.

The motto of geology to-day is that the processes of the present hour are the key to the interpretation of the past.

The energies in which the life of the earth is manifested are not only slow and gradual now, but it is believed that they have ever been the same, though many still doubt this.

The supposed age of Prof. Lobley's third period of the earth (*see* above) varies from thirty to a hundred million years, Prof. Tait indeed going as low as ten million years. This period (the duration of life on this globe, is said by astronomy (with regard, at any rate, to the possibility of life) to extend to fifty-six million years, and by chemistry to ninety-six million years.

Putting all these calculations together, Lobley, in common with some other geologists, gives a hundred million years for the utmost possible duration of animal life. Here, again, candour compels the admission that all this is not scientific truth, but vague borderland surmise.

Many will be surprised to know that records of organic life extend geologically, downwards from man at the surface, through thirty-four miles of rock.

Organic life is clearly found in pre-Cambrian layers, and doubtfully in the Laurentian, although to Sir William Dawson this latter appeared a certainty. Life extends backwards to Jurassic times in the Secondary Period. Some authorities (Darwin, Sir E. Ray Lankester, etc.) believe that, from the advanced character of the fauna in the Cambrian time (the largest known trilobite having come from the base of the Cambrian system), life must have existed for a long series of ages before this. If this be true, it is indisputable that, before the last Cambrian stratum was deposited, long periods elapsed, as long as, or probably far longer than, the whole interval from the Cambrian age to the present day, which is some five hundred million years. This estimate, of course, differs very widely from Prof. Lobley's.

The origin of the primitive rocks is still very obscure, and the assumption that there is any primordial solid crust to the globe seems now more than doubtful.

The Great Ice Age came at the close of the Tertiary Period, but its cause is decidedly a borderland question. Speculations about the supposed alteration at that time of the earth's axis are not yet scientific facts.

Between the Tertiary and Quaternary Great Ice Ages, in the Interglacial Epoch, evidence of human population is found in every part of the globe, in the forms of flint implements and human remains. They have been discovered in England, France, Spain, Egypt, South Africa, Palestine, North and South America, and India.

But in speaking of ages and periods we must ever remember that in geology the doctrine of distinct periods is now largely discredited. Prof. Clifford indeed says regarding this: " It is farther from the truth than any ancient cosmogony, and has done great harm to the progress of science; it was refuted many years ago by Herbert Spencer, and is now generally given up." It is found that rocks which are similar in structure are not necessarily contemporaneous.

While, then, the whole of the science of cosmogony is practically in the twilight of conflicting speculations, with regard to geology many facts and phenomena have rewarded the diligence of a century of scientific exploration. The difficulty is in their interpretation. Here much is illumined, but plenty of borderland twilight is left.

In geology the cause of the constant changes in the earth's surface resulting in inconstancy of oceans, as proved by the distribution of groups of animals, is one of the unsolved problems. Instances of this are innumerable. I will give two not generally known.

The only fresh-water jelly-fish are found in Lake Tanganyika in Africa. Geologists, to account for this, have devised the theory that Lake Tanganyika was once an arm of the sea, and, as the connection gradually dried up, apparently the water of the lake changed so slowly from salt to fresh that the jelly-fish were able to adapt themselves to the new element.

A special form of perch that carries its young in its mouth is found only in the Sea of Galilee and in a small lake in East Africa. It is suggested that at one time these were connected by water.

Other borderland questions are connected with the subjects of the crystalline structure of quartz; the sudden disappearance of enormous reptiles from the earth, which is as mysterious as their sudden appearance; and the curious magnetic variations of the compass. In 1580 the compass pointed N. by E.; in 1657 it pointed to true N.; in 1818 it pointed N.W. by N.; in 1908, N. by W.

CHAPTER XXVII

Astronomy

THIS is the oldest of all the sciences, and its facts and laws exceed in extent and accuracy those of almost every other science. Nevertheless, it is not without an extensive borderland.

The science of astronomy, which enables a man to predict what will happen in immensities of space and down long vistas of time, is not, after all, different in essence from the common knowledge by which a rustic foretells with certainty that one sort of seed will grow into a mustard plant, and another into a turnip. The wonder of both, overpowering when realised, lies not in the knowledge, but in the immutable laws, the majestic procession of phenomena, and the overwhelming but inscrutable forces that are revealed to us by its means.

We will briefly consider first one or two of the countless marvels in the astronomy of the solar system, and then in that of the stellar universe, together with some borderland questions in each.

Here is one marvel to begin with. Our solar system is travelling through space, and those who have reached 50 years of age are already two thousand million miles away from where they were born.* Whither are we travelling?

This system comprises the sun, eight planets, twenty-six moons, and some eight hundred minor planets

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* The distance may not be exact, for the velocity of the sun's movements is uncertain.

(asteroids). It must be remembered that the earth is three thousand times as massive as the eight hundred asteroids combined. Our solar system is very completely isolated from all other systems. Light traverses every part of it in about four hours, whereas to reach the nearest three fixed stars requires four, seven, and nine light-years respectively. (A light-year represents over five hundred million miles of distance travelled.)

The sun is 325,000 times the size of the earth, and yet it is an average-sized ordinary star. It would be large enough, if hollow, to hold a million earths, none of which would touch each other. In seventeen million years the sun will be reduced to a quarter of its present volume; it is continually shooting vast incandescent masses of gas upwards for a distance of 300,000 miles at 2,000 miles an hour; it is thus a vast storehouse of energy. It is possible that the solar corona which still survives is a trace of the primeval nebula from which the sun was evolved.

With its attendant planets the sun is nearing the constellation of Hercules at the rate of over half a million miles a day. Its present condition may somewhat resemble the state of our planet some ninety million years ago; whereas the moon might say to us, "Such as I am, thou too wilt be some day."

Prof. Young says: "If the sun were frozen over completely with ice to a depth of 50 ft., the heat it emits is sufficient to melt it in a minute of time."

The earth is kept in its orbit by the sun, which "attracts" it with a force of four trillion tons. It does not describe a circle round the sun, for as both are continually advancing through space the orbit never forms a closed curve.

The circulation of the heavenly bodies was discovered before the circulation of the blood; and one of the most depressing things in the whole history of science is the fact that the greatest scientific philosopher of his age, Francis Bacon, did not believe in the one or the other.

The new factor that entirely alters our estimates of the temperature of the earth and the sun, and threatens to throw all hitherto ascertained results into the borderland, and to shatter the fabric of reasoning raised upon them, is that of radium and radio-active bodies. These afford a new and unsuspected source of terrestrial heat.

A most remarkable fact, as yet unexplained, is that all the planets revolve in orbits nearly in the same plane. To illustrate this point, imagine the whole solar system put into a very flat bandbox, and all its members performing their revolutions entirely within the box, with the exception of a few asteroids. It is an equally remarkable and partly unexplained fact that the eight planets and eight hundred asteroids are all revolving round the sun in the same direction, which we call west by east. The sun rotates on its axis in the same way, but two of the moons of Jupiter, one of the moons of Saturn, the four moons of Uranus, and the one moon of Neptune revolve in the opposite way.

The very remarkable law of the relation of the revolutions of the planets to their orbits was discovered by Kepler. The story is worth telling.

When this great astronomer was 26 years old he proved that there were only six planets, and was so proud of the achievement that he said he would not barter the glory of it for the whole electorate of Saxony. Tycho Brahe advised him first to lay a solid foundation for his views by actual observation, and, by ascending from these, to strive to reach the causes of things. He returned to his labours and gave the result in his justly celebrated third law, viz. that the square of a planet's periodic time is proportional to the cube of its mean distance from the sun. This law gives a remarkable relation between the size of the planet's path and the time it takes to complete a revolution. When he discovered this, he wrote in a passion of joy: "What I prophesied twenty-two years ago; what I firmly believed before I had seen the harmonies of Ptolemy; what sixteen years ago I urged as a thing to be sought after, for which I joined Tycho Brahe, for which I settled at Prague, and for which I devoted the best part of my life, at length I have brought to life. The book is written to be read either now or by posterity, I care not which; it may well wait a century for a reader, as God has waited for six thousand years for an interpreter of His works." Kepler was born and died in poverty. The farther he penetrated into the mysteries of the universe, the more he recognised himself as but the instrument of the Almighty in making known His wonders, and he never entered upon an inquiry without praying for assistance from above.

The great planets are generally considered to be all uninhabitable by men, for many reasons. The temperature of space, for instance, according to Sir Robert Ball, is 300 degrees below 0° F.

It will have been noted that nearly every one of the interesting facts enumerated so far raises some borderland question. The causes of rotation, of solar energy, of solar "attraction," etc., are, of course, partly or wholly unknown. So also is much of the meaning of the newer facts of radio-activity, of spectrum analysis, of Martian canals, etc.

Turning now to the stellar universe, we find Sir Robert Ball saying: "The theory of probability declares to us with certainty that even within the distance that can be penetrated by our telescopes, the visible stars cannot form the millionth part of the total quantity of matter."

Prof. Campbell, of the Lick Observatory, says: "No progressive changes have been discovered in any celestial body, except in comets and some possibly new stars."

Prof. Hovenden, in common with so many other astronomical scientists, has felt but failed to solve the difficulty of believing that light from the stars could reach the earth without a medium; and yet that any such medium could exist without producing friction in the motions of the heavenly bodies. These borderland questions were mentioned in Chapter XXV.

The energy of the stars and their ages are unsolved problems of astronomy.

Spiral nebulæ exist that are far larger than our whole solar system; as to their origin, nothing whatever is known. The mystery of the spiral nebula, as the most characteristic object in the material universe, is the great question in astronomy to-day.

Mr. Easton, supported by Sir Robert Ball, has advanced the striking view that the Milky Way itself is a spiral nebula. This is still unproved.

These spirals abound in every part of the heavens; they are placed in every conceivable position; they have every range in size, and they are regarded as possibly the origin of the solar systems, including our own.

The number of stars visible through our largest telescopes is about seventy millions, but the number that can be recorded on photographic plates is several times as great.

It is interesting to note that the stellar system is generally believed by scientists to occupy a limited amount of space, somewhat the shape of a very narrow oval, the middle being the central plane of the Milky Way. The width of this flattened oval is about 3,000 light-years, and its length about 30,000. Our solar system is believed to be somewhere near the centre of this stellar system (which *may* represent the entire universe), in the Milky Way. A very remarkable fact is that this concept agrees in all important particulars with Immanuel Kant's description of the heavens in the year 1755. At the apparent rate at which our solar system is travelling, it would take about forty million years to reach the long radius of the stellar system.

At the average speed of the stars it would require over eighty thousand years for one to touch its neighbour; so that collisions must be exceedingly rare.

The tails of comets are now supposed to be composed of emanations of radium; and, as we have said, and Prof. Sollas, in his recent work on "The Age of the Earth," points out, our whole concept of the cosmos is destined to undergo a transformation in the growing light of new discoveries. This places the bulk of stellar astronomy in the borderland.

Alfred Russel Wallace advances three arguments in support of the finite character of the stellar universe, as opposed to its infinite extension:

"(1) In various parts of the heavens there are areas of considerable extent where stars are either absent or exceedingly few in number; we seem to look in fact through holes in the heavens, into starless depths of space beyond.

"(2) There is a steady increase in the number of stars down to the ninth or tenth magnitude; then it suddenly changes, and the number of stars of the seventeenth magnitude is only about one-tenth of what it would have been at the same ratio.

"(3) The total amount of light given by all stars of a given magnitude is twice as much as that of all the stars of two magnitudes higher. If this increase were maintained to the seventeenth magnitude, the light of all the stars combined should be seven times as great as that of moonlight, whereas it is only one-twentieth."

But alas! all these arguments fall to the ground if we admit the existence of dark stars; and, for all we know, the luminosity of our whole stellar system may be a very temporary affair! This whole question seems also placed in the twilight of uncertainty.

On the whole, we may say that the facts and laws of astronomy are probably more numerous and certain than those of any other science; which, considering the extreme difficulty and remoteness of the subject, is tribute of a high order to the patience and perseverance and powers of the world's great astronomers. It is, of course, also necessarily true that the extent of the astronomical borderland is quite unknown.

CHAPTER XXVIII

Anthropology, Botany, and other Sciences

In all illustrations of the borderlands of the various sciences given here we must ever remember that our subject is the borderlands of science and not of revelation; for, once we grasp this, we shall recognise that large tracts that are impenetrable to research and to inductive methods may be illumined and explained by revelation and deduction. This is, of course, especially the case in anthropology.

We shall, however, consider this subject according to our scientific lights, and shall confine ourselves to two points, the antiquity and the progress of the race.

Respecting the antiquity of man, we know generally that he is the latest product of this globe, and is comparatively of very recent origin; how many thousands of years he has existed cannot be said scientifically. All calculations from the Stone, Bronze, and Iron ages are fallacious, for those ages are assumed to have necessarily succeeded each other, whereas there can be no doubt that the Stone Age was contemporary in parts with the highest civilisation in Egypt, and that Egyptian life five thousand years or more ago was as highly developed in its way as our own. It is probable that their civilisation was even older than this, for I have myself seen good spring beds dating from the First Dynasty that were brought by Prof. Petrie to London, with other evidences of high technical skill. On the other hand, Paris only a thousand years ago was a swampy forest haunted by a few savages armed with stone axes, and yet, ages before, a highly scientific civilisation covered China and Babylon as well as Egypt. It is therefore a fallacy to suppose that the same civilisation marks a common era, which may be called an age, all over the globe. Another error, derived mainly from the evidence of skulls, is that a skull, or even a small fragment of one, can prove the low or high development of a race. As a matter of fact it proves nothing, *unless it can be shown to be an average skull of the period.* A prognathous skull with flattened frontal bones is no evidence whatever of a simian or even an inferior *type* of man of its period.

In England to-day individuals exist, in and out of asylums, with skulls containing brains of all sizes and corresponding to those of all periods of the world's history; and cave skulls (presumably of immense antiquity), whatever their shape, can be matched to-day. The conclusions as to racial development from individual skulls are therefore absolutely unreliable.

Haeckel has pointed out that within the limits of a single race the shape of a skull can vary indefinitely. A curious fact, when we think of evolution, is that the capacity of many of the skulls belonging to what is called the Stone Age, compared with the size of those of the men now living, is rather above than below the average. This is stated by Prof. Pfaff. So far, then, it is evident that we are in the twilight in these matters.

Prof. Bettex states that no work of human hands is known that can be proved to be older than six thousand years.* We may point out that this is the original biblical date of the creation of Adam, until the Hebrew text was altered by the Jewish Sanhedrin for a special purpose about A.D. 120, giving us the date of 4004 B.C., and robbing us of nearly two thousand years.

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* It must here be remembered that, at any rate from Adam till to-day, the chain of generations does not number more than 140.

Is the human race progressing? is another borderland question. This Great War has certainly said "No," in letters of blood, and indeed comes as a horrid nightmare to obsessed socialistic dreamers of man's advance in ethics and human brotherhood. The race as a whole has never yet been civilised, and it is a question whether the sum total of human intelligence has not been a constant quality at all times, developed in different directions in different ages. Personally, in common with many others, I can see no progress in mental or spiritual development, i.e. in man himself. No greater men flourish now than formerly. Inventions and discoveries do not connote greatness or an advance in humanity itself. There is no sign of real development in brain capacity, nor of any progress in comprehending or grasping larger ideas. No trace of the superman has yet been seen. Life is now so short, as compared with that of the patriarchs of ancient records, that it is probable they may have attained heights of intelligence not since equalled.

Even as to material greatness, ancient Babylon covered twice the area that is included in the city and all the fortifications of Paris, and was encircled by a wall 400 ft. high and 100 ft. broad. No such stupendous structure has ever been built as Baalbek. I took a large Government contractor there to see a stone as long as a cricket pitch, of 1,500 tons weight, which the builders would have had to move three-quarters of a mile to get into its position; and he said that no known force of men, hydraulics, steam, or electricity, or all combined, could do what he saw had been done there, and that at no price could he accept a contract to do it.

The complex civilisations of India, Egypt, Assyria, Persia, Phœnicia, and Carthage are generally but little known, though that of Greece and Rome is less unfamiliar and was in its own way quite equal to ours.

In 250 B.C. they built vessels manned by 4,000 sailors, and as large as our first-class Dreadnoughts. Their pigments have remained brilliant after 4,000 years, whereas ours would have disappeared ages ago. Their working in gold and enamels cannot be surpassed. They were perfectly familiar with the art of fitting artificial teeth with gold rivets, with trephining the skull, and with difficult obstetrical operations. They could saw enormous blocks of granite and syenite with the utmost precision by means of diamond and sapphire saws; although we considered the use of diamond borers in the St. Gothard Tunnel to be a fresh scientific triumph. They could also transport hundreds of pillars 6 ft. in diameter and 30 ft. in height from Upper Egypt down the Cataracts, over the sea and two ranges of mountains, to Upper Syria; whereas to convey one Cleopatra's Needle (one-half the size) to England taxed all our resources.

Only ignorance can hold cheaply these mighty civilisations, which have all disappeared as absolutely as if they had never existed. The whole littoral of the Mediterranean is a vast graveyard of dead Moorish, Roman, Grecian, Venetian, Phœnician, Egyptian, African, and Asiatic empires.

It is illogical to infer that because the ancients did not discover telephones or dynamos (things for which they never looked), they were intellectually our inferiors. On the contrary, their abstruse mathematical calculations, as shown in the Pyramids, in the orientation of temples, and in the construction of zodiacs, are so intricate and scientific that they must have been at least our equals.

Prof. Holzer says: "To talk of progress is mere specious verbiage for the successive subjugation of refined civilisations by more robust physical barbarians, which is undoubtedly the rule in history." With this Huxley agreed. It is, therefore, doubtful indeed whether Greece and Egypt did not both surpass us in many arts and in some sciences.

Thus neither the progress of the race nor its antiquity is yet established as a scientific truth, but both are certainly borderland questions in anthropology.

Turning to botany, in the vegetable kingdom borderlands abound, and unsolved problems lie all around us. We will touch on a few at haphazard.

The rise of sap in a tree in springtime has always been a puzzle to botanists; and capillary attraction only shifts the difficulty a step farther back, but does not remove it. The production of fruit is another mystery, which we have touched upon from the point of view of evolution, in Chapter XVII.; indeed, the whole process of formation of fruit, which resembles nothing else in the plant or tree, is part of the generally unsolved problem of reproduction.

The cause of successful grafting, which depends on a deep-seated kinship between the parts and a specific likeness in their cells, is still a deep mystery.

The bean always climbs from right to left, whereas the hop always climbs from left to right; this is as inscrutable as are differences in the buttoning of men's and women's clothes, which varies in the same way the world over, and for which no adequate reason has been found.

Some of these minor borderland questions, indeed, seem at first sight so easy, and on deeper thoughts so impossible, of solution that they are positively irritating.

The whole question of colour and form in flowers is by no means wholly solved by the necessity for fertilisation, for, although much light has been thrown upon it by fertilisation, a large part of it still remains in twilight. The colour and beauty in nature present a most perplexing mystery, as does the fact that what appear to be the most beautiful flowers, insects, birds, and fishes haunt those parts of the world which are more or less inaccessible to man.

The electrical culture of wheat in many cases more than doubles the crop, and in strawberries this is especially marked; but the reason has never been satisfactorily explained.

How it is that nitragen, a solution of germs used to nourish the roots of plants, succeeds in extracting the nitrogen of the soil and transferring it to plants, is another thing not yet entirely understood.

Where the vegetable kingdom actually begins and ends is really a borderland question; for the division between the animal and vegetable kingdoms is most obscure, and even between the vegetable and mineral kingdoms it is by no means clear. The line between organic and inorganic chemistry, as we saw in an earlier chapter, is disappearing. True digestion in plants, as for instance by the leaves of the sundew, is as real and complete as our own, and very similar to it. The movements in plants are also similar in kind to the movements in our bodies.

Movement, as we all know, is not confined to organisms, for it is the law of the molecular world and is there perpetual. The mere automatic motility of unicellular organisms was at one time considered sufficient indication that such organisms were animals rather than plants. We now know that not only are the male reproductive cells of ferns and similar plants propelled by vibratile protoplasm, but that such locomotive particles are recognised as common products of the lowest plants.

The last borderland question which we will ask in this science is, Which came first, the vegetable or the animal ?

Sir E. Ray Lankester says : " We are allowed to entertain the paradox that though the animal is dependent upon the plant for its food, yet the animal preceded the plant in evolution ; and we look among the lowest protozoa (animal) and not among the lower protophyta (vegetable) for the nearest representatives to that first protoplasm which was the result of a long and gradual evolution of chemical structure, and was the starting-point of the development of organic form."

Although, with many others, we do not agree with Sir E. Ray Lankester's unproved inferences with regard to evolution, his remarks on the protozoa appear to be probably right ; but it is impossible to say that they are as yet established beyond contradiction.

In conclusion, we gather up here one or two fragments of borderland questions in some of the sciences that we cannot consider separately.

In mathematical science some of the most precise and beautiful theorems seem to involve apparent contradiction. In " The Principles of Science " Stanley Jevons asks : " Can we imagine that a point moving along a perfectly straight line towards the west would ever get round to the east, and come back again, having performed a circuit through infinite space without ever diverging from a perfectly straight direction? Yet this is what happens to the intersecting point of two straight lines in the same plane when one line revolves.

"The same paradox is exhibited in the hyperbola regarded as an infinite ellipse, one extremity of which has passed to an infinite distance and come back again in the opposite direction.

"A varying quantity may change its sign by passing either through zero or through infinity."

The fourth dimension may be classed by some, as I have done in "Another World, or the Fourth Dimension," as a possible borderland question, for its problems are very analogous to those of the spirit world.

In the science of painting and drawing, may we not class the value of post-impressionism, cubism, and futurism, certain points in focus and perspective, and the meaning of "beauty," as borderland questions?

In the science of music, the question of what really constitutes true music is still in the borderland. What are we to say of farmyard operas, and some of the compositions of Strauss, and even some of Wagner's, and also the real relations of harmony and discord to each other and to music? How far is the "music" of native Africa and Asia rightly so called?

In 1830 Mesmer discovered what he called animal magnetism, which is still a borderland question.

In theology two scientific utterances, among many, occur to me, of which the exact meanings are in the twilight. One is the statement, "Upholding all things by the word of His power." The second is, "By Him all things consist (or cohere)." In Chapter XXV. we saw that this coherence, as seen in chemical affinity, is not understood.

Other Sciences

The borderland between science and religion is an extensive one, which men cannot be prevented from exploring; but what they may find there depends very much upon themselves. Scientifically (not theologically) God Himself is in the borderland as being assumed and not proved.

One group of scientific theories on this subject is ontological, and attempts to prove the objective existence of God from the subjective notion of His necessary existence in the human mind.

Another group is cosmological, and essays to prove the existence of God from the very fact of the existence of the world, and by the application of the principle of causality.

A third group is teleological, and evolves God not from the mere fact of the existence of the world, but from its character as constructed; not only by design, but for special objects and ends.

A fourth group is ethical, and asserts that conscience is the moral echo in the soul of a greater voice without.

A fifth and last group is intuitive, and is the only one that is unassailable. It is really not an argument, nor an inference, nor a conclusion, but an attestation of God in the soul, as shown by the instinct of worship in the human mind.

Nevertheless, one cannot quite say that the lights of reason alone have actually proved the existence of the God of revelation.

CHAPTER XXIX

The Message of the Twilight, and Summary

THE reader will perhaps rise from a consideration of the chapters of Part II. of this volume with great and growing amazement, perceiving how much there is of borderland surmise in each separate science, organic or inorganic, and how little of scientific fact.

To say this is to cast no reflection on the marvels of applied science. We are daily too greatly indebted to its triumphs to belittle its achievements.

Moreover, if the borderland be wide, we must remember that it is because twilight has so largely replaced absolute darkness; which after all is a great advance. Nearly all of it has been rescued, and most of it quite recently so, from the unknown. Remember, too, that though the centre of the disc (which, we are gradually finding, is, like the centre of a watch, the source of power and life) is but a unit and a point, the circumference is vast and of immense extent; while all around it stretch an innumerable band of scientists as busy as ants, whose labours extend more in breadth than in depth. Not only so, but in all that is unknown there are two branches of study—the one, that which must be known; and the other, that which it is not essential to know. Science, as a rule, carefully distinguishes between the two, and pursues that which yields a valuable return.

No doubt, in molecular physics, in speculations on ether, gravitation, and the like, some of the results appear absurd, and are indeed mutually contradictory. But this is due to the absolute truth of scientific reports. There is no gloss, no adaptation, no cooking of accounts here! There is little doubt that a clear and simple answer to any profound scientific question must be untrue; for nothing in this region is either simple or clear.

And, lastly, only great knowledge could reveal so great ignorance. Those who know nothing have no conception of the real ignorance of science, which knows so much, nor do they see that this ignorance is in a sense due to advancement in knowledge.

The paradox is therefore true that the vast extent of twilight borderland, rightly viewed, is one of the glories of science.

And now, as the summary of the whole matter, I will give as briefly as possible the personal impressions which result from the survey of science and of the various borderlands that form the twilight region of the vast disc of our initial conception.

It seems to me that the whole range of science in reference to the borderland readily subdivides itself into three groups: the first, where the borderland predominates; the third, where scientific truth predominates; and the second, between the first and third, where the two are fairly equally divided. I need hardly say that I do not (and could not) include all the sciences in this classification, but refer especially to those named in these pages. Nor do I suppose for one moment that anyone will entirely agree with my classification; nevertheless I give it for what it is worth.

In the first class, where the borderland preponderates, I place the sciences of anthropology, biology, chemistry, cosmogony, electricity, light, molecular physics, morphology, ontogeny, phylogeny, physics, and psychology.

In the second class, where the borderland and scientific truth are fairly equally divided, I place the sciences of astronomy, atmology (the science of the air), botany, economics, geology, thermotics (heat), mathematics, medicine, mineralogy, painting, physiology, zoology, and theology.

In the third class, where scientific truth predominates, I place the sciences of æsthetics, anatomy, arithmetic, ethics, geometry, grammar, logic, mechanics, music, rhetoric, and sociology.

There are two points of interest which have deeply impressed me in writing this book. The first is the increase of the borderland, on which I have just touched, and the second the general trend of science.

As to the first point, I need not repeat that there never was a time in the history of science when there were so many partly solved questions in every branch, and such an extent of borderland, as now, marking an increase not of ignorance but of knowledge. This was largely unlooked for. No one expected the discovery of radium or of electrons, or anticipated the necessity for postulating ether. It was the advance of science that produced these and with them other large tracts of borderland. All this makes the realm of scientific truth look more limited than ever, and emphasises the vastness of the region still to be explored.

The trend of science is still more interesting and unexpected. How shall I describe, in conclusion, the vision that it presents to me?

Perhaps I may be allowed to compare the scientist's present position with that of a child at the unveiling of the transformation scene towards the close of its first pantomime. So far it has been greatly interested in the various parts of the story, and quite believes that nothing more wonderful remains, when, lo! the dim suffused light that now fills the stage brightens as a gauze curtain rises; veil after veil slowly follows, and the golden glory gradually grows and grows until, when the last screen is gone, the child's enraptured gaze bespeaks emotions too deep for words.

Is this too vivid a picture of the soul of a great scientist? His whole career has been that of growing wonder at the marvels of nature; and now, in his advancing years, armed with the mighty powers of modern instruments, he pursues the investigation of the natural universe. As he proceeds from the circumference towards the centre, and veil after veil disappears, he discovers that the apparently stationary is eternally mobile; the solid world dissolves bit by bit under his very eyes, and then vanishes—first into ether, then into electricity, then into energy or force; and even here he cannot stop. As the last veil goes he perceives that the force is absolute, and that Absolute Force is the one great Cause of all. Thus, by a path he knew not, step by step approaching the central light, along the brightening road of modern science, he finds himself, as the last cloud dissolves, standing in the perfect day —in the unclouded presence of the Divine glory.

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